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METEOROLOGICAL OFFICE
23 FEB 1979
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MET O 11 TECHNICAL NOTE NO. 124

THE OCEAN WEATHER SHIPS TRIAL OF DECEMBER 1978

128863

by

G.J. BARNES and D. IRELAND

Met O 11 (Forecasting Research Branch)
Meteorological Office
London Road
Bracknell
Berkshire
UK

February 1979

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Introduction

From the 8 December 1978 to 29 December 1978 two series of 10-level model analyses were produced. Neither series contained any intervention, and whilst one series contained information from weather ships, the other did not. Both sets of analyses were used to run forecasts to generate background fields for the subsequent analyses and thus, except for the initial conditions at the beginning of the experiment, were independent of one another.

The output from these two sets of analyses were compared/ and 12 cases were selected from which to run 36hr octagon and rectangle forecasts. The appraisal of each set of analyses was mainly subjective but an attempt has been made to introduce some objectivity into the study of the subsequent forecasts. It must be emphasised that these findings are preliminary and many of the following comments and results are incomplete.

The rest of this note is arranged in the following sections.

1. General comments on the subjective assessment of the analyses.
2. Notes on the individual cases selected with some subjective assessments of the subsequent forecasts.
3. Objective verification of the forecasts.
4. Some important cases.
5. Conclusions.
6. Charts.

1. General Comments on the Subjective Assessment of the Analyses

The analyses were appraised subjectively to select these it was thought would produce differing forecasts. Of the 44 pairs available for comparison, it was thought that in 6 cases

an appreciable difference would arise in the forecasts over an area at least as large as, say, the southern half of England. In a further 23 cases it was thought that some smaller differences would arise, leaving 15 of the 44 cases where it was thought that differences in the forecast would be minimal.

It should be noted, however, that in the past, cases have been found where forecasts have diverged markedly from initially similar analyses.

Of the above, forecasts were in fact run from 5 of the 6 main cases and 7 of the 23 minor cases.

Analysis charts were available for:-

OCTAGON AREA (300km mesh - North of 15°N)

300 mb Height, isotachs
500 mb Height
Surface Pressure

RECTANGLE AREA (100km mesh - N.Atlantic. W.Europe)

300 mb Height
500 mb Height
Surface Pressure
950, 850, 700, 500, 400 Humidity

It was thought that as the run without ships produced its own background field the analyses might diverge with time; in fact what appeared to happen was that every so often (never more than every two days) enought information would come in to get a good analysis without recourse to weather ships, and the two sets of analyses would become similar again. For this reason the charts that were noted as being different tended to come in runs of two or three. There were no cases of the surface and 300 mb charts both being markedly different at the same time.

At 300 mb it was apparent that, of the ships, 'Ø7C' was the one most noticeably missed by the analysis. It is, of course, the furthest from land. This was followed by 'Ø7R' then 'Ø7L'. That 'Ø7R' should be missed more than 'Ø7L' is probably largely a function of the synoptic pattern of the period, which was often zonal along 45N and stagnant further north. It is probable however that 'Ø7L' at 300 mb is the more frequently covered by AIREPS as it is on a Great Circle track

from much of Europe to the Eastern seaboard of America.

'Ø7M' appeared to make little contribution to the numerical analysis. It is fairly close to land and is close to some of the polar flight tracks.

On the surface '07C' was again missed most and '07M''s presence or absence barely detectable, but it was more difficult to decide whether 'Ø7R' or 'Ø7L' was the more important. They are both roughly the same distance from land and their influence would be largely determined by the numbers of ships in their vicinity, and the quality of the background field.

As an indication of the effect of the absence of weather ships, Table 1 gives the Root Mean Square of the difference in values at 300 mb and the surface at the weather ship positions. Heights were estimated to the nearest decametre at 300 mb, and the nearest mb at the surface.

TABLE 1

RMS at OWS Position

	C	R	L	M
300 mb (DM)	4.9	5.0	4.4	1.5
Surface (MB)	3.4	1.1	3.1	0.6

These figures tend to support the subjective assessment, but due caution should be taken in interpreting them. Aside from the relatively small sample, the bare numbers do not describe the shape of the contour patterns (often at least as important as absolute values) or may not indicate a great departure in the forecast; for example, although the pressure near '07L' was about 10 mb different on two occasions (which affected the RMS), it was at the centre of old occluded lows, and the forecast weather would have been little different apart from the resultant pressure.

Differences in humidity were mostly considered negligible, usually being less than 20%. This would seem to be about the order of difference between the different types of sondes, a factor which the model does not allow for. Occasionally when differences were larger they were often in a small area centred around a ship.

This would be modified in a forecast towards the larger scale. Consequently at no time was humidity considered a primary factor in causing a significant difference in forecasts, though twice it was thought it would exacerbate other factors.

It was thought that over the Christmas period, the lack of aireps and ships would degrade the analyses and therefore the forecasts. In fact there was no indication of this; there were presumably sufficient ships and aireps even then.

(On the 25th and 26th Dec over Atlantic there were an average of 67 aireps and 82 ships compared with 8th and 9th Dec " " " " 97 aireps and 150 ships).

2. Notes on the individual cases selected with some subjective assessment of the subsequent forecasts.

Data Time ØØZ 8th

ANALYSES

(a) SURFACE (SOUTHERLY FLOW OVER UK)

The analyses with weather ships, without and operational were very similar, particularly so away from the weather ships. However a certain low was slightly differently analysed in the three cases

WITH	WITHOUT	OPERATIONAL
953mb 55N 21W	960mb 55N 21W	951mb 55.5N 26W

(b) 300mb (SOUTHERLY FLOW OVER UK)

Almost identical but slight differences in a low at about 52N 22W

WITH	WITHOUT	OPERATIONAL
849dm	850dm	848dm

Data Time ØØZ 11th

ANALYSES

(a) SURFACE (SOUTHERLY FLOW OVER UK)

There was a double low to the west of the UK which was part of a vast complex low.

One of the low centres was analysed as below

WITH	WITHOUT	OPERATIONAL
957mb 46N 17W	956mb 46N 17W	958mb 46N 17W

whereas the other part of the double low further north was

WITH	WITHOUT	OPERATIONAL
969mb	972mb	969mb

(b) 300mb (SOUTHERLY FLOW OVER UK)

Pattern virtually identical but a low centre at about 59N 13W differed in depth between the analyses.

WITH	WITHOUT	OPERATIONAL
862	872	862

Data Time 12Z 11th

ANALYSES

(a) SURFACE (SOUTHERLY FLOW OVER UK)

Complex low west of British Isles with 3 centres.

WITH	WITHOUT	OPERATIONAL	APPROX POSITION
964	961	962	52N 16W
965	972	962	50N 36W
974	974	974	58N 50W

(b) 300mb

Almost identical.

Data Time ØØZ 13th

ANALYSES

(a) SURFACE (SOUTH WESTERLY FLOW OVER UK)

Double low west of British Isles.

WITH	WITHOUT	OPERATIONAL	APPROX POSITION
960mb	959mb	960mb	55°N 10°W
958mb	957mb	958mb	57°N 32 W

There was a more pronounced ridge without weather ships south west of the UK.

(b) 300mb (WEST SOUTH WESTERLY FLOW OVER UK)

Similar charts but again slight difference in the depth of a low

WITH	WITHOUT	OPERATIONAL	APPROX POSITION
847dm	841dm	846dm	55°N 30W

Data Time ØØZ 16th

ANALYSES

(a) SURFACE (NORTH EASTERLY FLOW OVER UK)

Very similar except for high west of UK

WITH	WITHOUT
1028	1024

(b) 300mb (NORTH EASTERLY FLOW OVER UK)

Analysis with weather ships has a slightly stronger jet over the British Isles.

(c) RELATIVE HUMIDITY

Differences of up to 10% at higher levels but virtually identical lower down.

FORECASTS

300mb forecast virtually identical but slightly stronger flow over UK with weather ships.

forecast surface pressure also very similar

forecast rainfall very similar

Data Time 12Z 16th

ANALYSES

(a) SURFACE (NORTH EASTERLY FLOW OVER UK)

Very little difference

(b) 300mb (NORTHERLY FLOW OVER UK)

Very little difference.

FORECASTS

All forecasts virtually identical.

Data Time ØØZ 17th

ANALYSES

(a) SURFACE (NORTHELY FLOW OVER UK)

Large difference in low

WITH 1004mb 52N 30W

WITHOUT 1014mb 45N 35W

(b) 300mb (NORTHELY FLOW OVER UK)

Slight difference in ridge west of UK

(c) HUMIDITY

Closer still at all levels than ØØZ 16th.

FORECASTS

Ridge at 300mb over UK slightly different giving stronger winds with weather ships at 36 hr.

Large difference at 36 hr in surface low octagon.

WITH	67N	22W	981mb
WITHOUT	66N	30W	996mb
VERIFICATION			980mb

Data Time 12Z 17th

ANALYSES

(a) SURFACE (NORTH EASTERLY FLOW OVER UK)

Very little difference.

(b) 300mb (NORTHERLY FLOW OVER UK)

Very little difference.

FORECASTS

36 hr SURFACE OCTAGON FORECAST

WITH	986mb	68N	7W
WITHOUT	992mb	68N	6W

however the 35 hour rectangle forecast for this low gives no difference in central value

Data Time ØZ 23rd

ANALYSES

(a) SURFACE (SOUTHERLY FLOW OVER UK)

Difference in low

WITH	982mb	45N	18W
WITHOUT	999mb	46N	13W

(b) 300mb (SOTHERLY FLOW AT 300mb)

Difference in low to west of UK

WITH 875dm

WITHOUT 878dm

(c) HUMIDITY

Differences of order ZØØ at 400mb and 40% at 850mb

FORECASTS

300mb forecasts are quite different. For example without weather ships a low exists over the UK to which none correspond on the forecast from data with weather ships.

Surface forecasts are very different since the forecast with weather ships has a far deeper low crossing the UK giving much more rain especially at T + 24 and onwards.

Data Time 12Z 23rd

ANALYSES

(a) SURFACE (SOUTHERLY FLOW OVER UK)

Difference in low

WITH	48N	13W	977mb
WITHOUT	48N	10W	982mb

(b) 300mb (WESTERLY FLOW OVER UK AT 300mb)

Different pattern north of UK but only 1dm difference or so.

(c) HUMIDITY

Not such large differences as in the previous case.

FORECASTS

300mb forecasts very similar

suface low centre slightly deeper with weather ships

Data time ØØZ 24th

ANALYSES

(a) SURFACE (SOUTHERLY FLOW OVER UK)

Very similar analyses: little difference in pressure of low SW of UK.

(b) 300mb

Similar but slight difference in a low at about SSN 20W

WITH	WITHOUT
865dm	870dm

(c) HUMIDITY

13% or so differences at 400mb

10% " " " " 500mb

25% " " " " 700mb

27% " " " " 850mb (intense low round weather ship!)

FORECASTS

Very little difference

Data time 12Z 25th

ANALYSES

(a) SURFACE (SOUTHERLY FLOW OVER UK)

Very similar

(b) 300mb (SOUTH WESTERLY FLOW OVER UK)

Very similar

FORECASTS

300mb forecasts almost identical

surface forecast low west of UK little deeper with weather ships.

3. Objective verification of forecasts.

(i) Comparison with observations

Each 36 hr octagon forecast was verified in an area similar to the rectangle area against observations.

300mb HEIGHTS RMS dm

LAND			SEA		
WITH	WITHOUT	OPERATIONAL	WITH	WITHOUT	OPERATIONAL
10.11	10.82	8.12	7.64	9.35	4.99
11.17	11.01	12.02	9.54	11.45	8.54
18.58	17.85	18.48	15.33	12.58	14.39
13.01	15.47	11.95	10.79	16.62	10.22
6.99	7.71	6.59	2.99	3.12	2.18
4.93	4.67	7.30	4.73	2.29	4.96
3.05	4.11	5.02	.84	5.79	3.51
4.95	4.07	5.35	12.22	12.16	12.69
8.12	4.94	8.77	17.68	18.02	18.63
9.41	8.70	9.20	12.27	12.63	5.26
6.33	5.43	5.16	7.65	6.49	3.84
5.91	6.16	5.25	1.82	3.20	1.69
9.47	9.48	9.40	10.2	10.75	9.15

The first 12 numbers are the values of $\sqrt{\frac{\Sigma(\psi_i^o - \psi_i^F)^2}{N}}$ for all observations in the area either over land or sea for each forecast where ψ_i^o is the observed value of the field and ψ_i^F the forecast value.

The final number is the mean value for all the forecasts.

SURFACE PRESSURE RMS mb

LAND			SEA		
WITH	WITHOUT	OPERATIONAL	WITH	WITHOUT	OPERATIONAL
3.66	3.84	3.75	4.74	5.12	4.35
12.86	12.04	13.51	14.54	14.32	15.01
18.00	18.44	17.66	17.33	18.30	17.03
11.24	13.02	7.88	11.02	12.66	8.04
5.87	6.68	5.82	3.58	4.11	3.41
4.82	4.49	6.25	5.60	4.71	6.09
2.76	4.52	3.93	2.22	3.49	3.67
4.83	4.49	5.23	4.06	3.69	4.21
6.83	10.98	6.70	8.95	13.05	9.19
5.53	5.48	3.82	5.26	5.71	3.94
5.26	5.11	3.89	5.44	5.70	4.39
3.57	3.35	3.23	3.72	3.61	3.37
8.34	8.96	8.02	8.5	9.31	8.21

850mb RELATIVE HUMIDITY RMS %

LAND			SEA		
WITH	WITHOUT	OPERATIONAL	WITH	WITHOUT	OPERATIONAL
21.85	21.74	20.69	18.21	17.89	18.66
19.74	19.77	20.35	6.71	7.19	2.25
20.85	22.48	20.93	6.93	18.46	6.19
16.91	17.27	15.67	6.51	9.81	5.79
24.34	24.31	24.97	39.56	59.28	41.97
22.06	22.51	27.46	7.89	7.89	14.65
25.04	25.20	27.10	19.15	2.51	18.64
24.31	25.68	22.96	14.17	19.54	15.30
16.35	16.64	16.96	14.43	13.86	13.33
19.61	20.05	20.19	7.88	9.75	8.03
23.17	24.27	23.31	5.19	6.13	4.14
18.73	19.12	19.09	8.93	5.98	9.13
21.26	21.78	21.92	15.91	19.51	16.43

300 MB RMS Vector Wind Error Knots

LAND			SEA		
WITH	WITHOUT	OPERATIONAL	WITH	WITHOUT	OPERATIONAL
27.91	28.49	26.07	34.35	32.42	35.24
31.76	30.64	35.24	27.77	31.25	28.14
39.96	37.98	37.63	18.17	21.90	16.27
33.67	33.07	33.68	38.50	49.47	31.29
30.89	31.01	29.61	27.00	31.47	24.13
31.38	30.20	29.54	5.39	5.57	17.14
17.84	22.59	23.27	17.33	25.97	15.62
21.53	16.36	22.40	29.49	25.24	25.63
38.88	33.19	37.25	18.91	19.48	15.45
31.91	30.53	30.75	26.87	27.56	27.61
20.66	21.06	18.15	38.11	49.13	34.38
24.05	24.19	22.37	43.46	42.71	44.77
29.16	28.87	28.79	29.03	32.00	27.75

The figures indicate that there is little difference between the forecasts.

The forecast from data with weather ships is better than the forecast from data without weather ships in 7 out of the above 8 tables (the exception being RMS Vector Wind error Land).

The operational forecast is the best of all in 6 out of the 8 tables (the exceptions being 850mb Relative Humidity Land and 850mb Rehtive Humidity Sea)

(ii) Verification of Rate of Rainfall Forecasts

For each forecasts charts of rate of rainfall were produced at T + 6, T + 12, T + 18, T + 24, T + 30, T + 36.

These forecasts were objectively verified by noting whether or not the forecast implied it was raining at 3 stations in the UK, Scilly, Glasgow and London and comparing with reality.

Only cases where rain occurred were examined

In each case the first space applies to Scilly, the second to Glasgow and the third to London.

	T + 6	T + 12	T + 18	T + 24	T + 30	T + 35	Number Correct
			00Z 8th				
OPERATIONAL	✓ X ✓	X ✓ ✓	✓ ✓ X	X X X	✓ X ✓	X ✓ X	13
WITH	✓ X ✓	X ✓ ✓	✓ ✓ X	X ✓ ✓	✓ X X	✓ ✓ ✓	12
WITHOUT	✓ X ✓	X ✓ ✓	✓ ✓ X	✓ ✓ X	✓ X X	✓ ✓ ✓	12
ACTUAL	✓ X ✓	✓ ✓ ✓	X ✓ X	X ✓ X	X X X	X ✓ X	18
			ØØZ 11th				
OPERATIONAL	✓ X X	✓ X X	✓ X X	X X ✓	✓ X X	X ✓ ✓	9
WITH	✓ X X	✓ ✓ X	X ✓ ✓	✓ ✓ ✓	✓ ✓ X	✓ X X	11
WITHOUT	✓ X X	✓ X X	✓ X ✓	✓ ✓ ✓	✓ X ✓	✓ ✓ X	7
ACTUAL	X X X	X ✓ X	✓ ✓ ✓	X X ✓	X ✓ X	X X X	18
			12Z 11th				
OPERATIONAL	X X X	X ✓ ✓	✓ X ✓	X ✓ ✓	✓ X X	X ✓ ✓	7
WITH	✓ X X	✓ ✓ ✓	✓ X ✓	X ✓ ✓	X X X	✓ ✓ ✓	7
WITHOUT	✓ X X	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ X	X X X	X X X	5
ACTUAL	✓ ✓ X	X X ✓	X ✓ X	X X X	X X X	X X X	18
			00Z 13th				
OPERATIONAL	✓ X ✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	X ✓ ✓	2
WITH	X X ✓	✓ ✓ X	✓ ✓ X	X ✓ X	✓ ✓ X	✓ ✓ X	8
WITHOUT	X X ✓	✓ ✓ X	✓ ✓ X	X X X	✓ X X	✓ ✓ ✓	9
ACTUAL	X X X	X X X	X X X	X X X	X X X	X X X	18

(✓s imply rain, Xs imply no rain)

ØØZ 23rd

							Number Correct
WITHOUT	✓ X X	✓ X X	✓ X X	X X ✓	X X ✓	X X X	14
WITH	X X X	✓ X X	✓ X ✓	✓ X ✓	✓ X ✓	✓ ✓ ✓	13
ACTUAL	✓ X X	✓ X X	X X ✓	✓ X ✓	X X ✓	X X ✓	18

12Z 23rd

WITHOUT	✓ X ✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	X ✓ X	✓ X X	9
WITH	✓ X ✓	✓ ✓ ✓	✓ ✓ ✓	X ✓ X	✓ ✓ X	X ✓ ✓	9
ACTUAL	X X ✓	✓ X ✓	X X ✓	X X ✓	X ✓ ✓	X ✓ X	18

ØØZ 24th

WITHOUT	✓ X ✓	X X ✓	✓ X ✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ X	11
WITH	X X ✓	✓ X ✓	✓ X ✓	✓ ✓ X	✓ ✓ X	✓ ✓ ✓	11
ACTUAL	X X ✓	X X ✓	X ✓ ✓	X ✓ X	X ✓ X	X ✓ X	18

12Z 24th

WITHOUT	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ X	✓ ✓ X	✓ ✓ X	✓ ✓ X	12
WITH	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ X	✓ ✓ X	✓ X X	X X X	9
ACTUAL	X ✓ ✓	X ✓ X	X ✓ X	X ✓ X	X ✓ X	✓ ✓ X	18

		FIRST 4 FORECASTS	ALL FORECASTS
TOTALS	OPERATIONAL	31/72	
	WITH	38/72	80/144
	WITHOUT	33/72	79/144

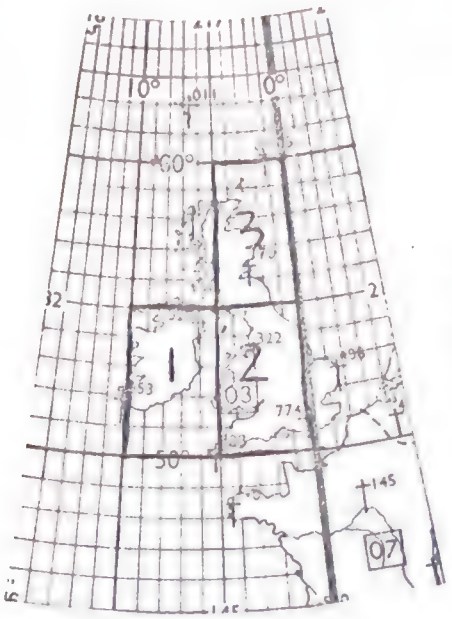
There is hardly any difference between the skill of forecasts in deciding whether it is raining or not at particular stations.

Objective Verification of Accumulated Rainfall

5 of the forecasts in which rain was produced were selected at random and accumulated rainfall was verified against observations.

The forecast produces charts of accumulated rainfall at gd pts for (T + Ø)-(T + 6), (T + 6)-(T + 12), (T + 12)-(T + 18), (T + 18)-(T + 24), (T + 24) -(T + 30) and (T + 30)-(T + 36) .

From these charts the total rain falling on the areas shown below in these periods was calculated.



numbers shown are the area numbers.

In the DWR rainfall amounts falling at about 35 stations in the British Isles are recorded for the 12 hour periods Ø9Z - 21Z and 21Z - Ø9Z.

These rainfall amounts for the periods

21Z	11 -	9Z 12	called	PERIOD 1
Ø9Z	12 -	21Z 12	"	PERIOD 2
9Z	23 -	21Z 23	"	PERIOD 3
21Z	23 -	9Z 24	"	PERIOD 4
9Z	24 -	21Z 24	"	PERIOD 5
21Z	24 -	9Z 25	"	PERIOD 6

were verified against all relevent forecast periods (interpolating for the forecast periods passing through Ø9Z and 21Z) produced from data

ØØZ	11th
ØØZ	23rd
12Z	23rd
ØØZ	24th
12Z	24th

RESULTS

PERIOD	1			2			3			4			5			6		
VERIFYING AREA	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
RECORDED RAINFALL	5.8	4.5	3.5	3.9	3.9	2.8	7.3	3.9	2.6	3.4	3.6	.9	2.1	4.6	4.5	2.2	1.9	5.9
DATA TIME																		
ØØZ 11th WITH	2.7	2.0	.33	2.5	2.3	1.3												
WITHOUT	1.7	1.2	.28	1.2	1.0	.46												
ØØZ 23rd WITH							3.9	2.9	.25	3.8	4.3	.64						
WITHOUT							1.0	2.0	.31	.43	1.3	.73						
12Z 23rd WITH										1.7	3.5	1.7	2.6	2.3	3.5			
WITHOUT										2.5	5.9	3.0	.48	1.2	5.4			
ØØZ 24th WITH													3.1	3.9	.94	2.0	3.3	2.2
WITHOUT													2.1	4.0	.74	1.9	3.0	1.6
12Z 24th WITH																1.2	1.7	4.1
WITHOUT																1.2	1.7	3.6

Looking at the figures indicate that the forecasts with weather ships are usually better and this is borne out by computing the RMS rainfall amount error.

WITH WEATHER SHIPS	1.9
WITHOUT WEATHER SHIPS	2.6

(all figures in mm)

'iii) Comparison of the Depths of lows at the surface and 300mb

All low centres at 300mb in the octagon between 90°W and 90°E and at the surface in the rectangle which could be clearly identified as being equivalent in the forecasts and verifying analyses were compared as regards their depth.

RESULTS

300mb dm

OPERATIONAL	WITH	WITHOUT	VERIFICATION		APPROX	POSITION
843	844	844	838	ØØZ 8th	54N	87W
852	850	852	841		58N	36W
819	819	819	816		64N	61E
830	828	827	844	ØØZ 11th	50N	43W
826	825	826	820		67N	61E
831	830	827	846	12Z 11th	52N	22W
823	822	822	818		64N	55E
851	851	851	846	ØØZ 13th	55N	84W
860	862	856	853		56N	5E
853	852	849	852	ØØZ 23rd	49N	51W
894	891	893	898		38N	27E
855	854	854	855	12Z 23rd	50N	43W
894	896	895	897		41N	36E
855	854	853	852	ØØZ 24th	48N	35W
898	899	899	899		42N	35E
854	855	855	859	12Z 24th	48N	71W

RMS DEVIATION FROM VERIFICATION

With	7.3
Without	7.7
Operational	6.9

SURFACE mb

OPERATIONAL	WITH	WITHOUT VERIFICATION			APPROX	
966	968	964	963	00Z 8th	56N	36W
950	957	960	950	00Z 11th	59N	36W
958	957	960	958	12Z 11th	58N	30W
974	979	981	974	00Z 13th	55N	1W
971	985	996	980	00Z 17th	68N	14W
976	983	983	978	00Z 23rd	52N	23W

RMS DEVIATION FROM VERIFICATION

With	5
Without	8.5
Operational	4.0

These figures all indicate that the operational forecast is best and the forecast from analyses containing weather ship data but no intervention next best. The ratios of the RMS figures among the various types of forecast here are larger than the ratios of the RMS figures produced by verifying against observations.

4. Some Important Cases

As mentioned previously, on at least five occassions there were large differences between the two surface analyses, and these, together with the resulting forecasts, are depicted in figures 1 to 5. Also included in these figures are the hand drawn analyses of the Central Forecasting Office which are used as verification. For reasons of space, the area of the charts has been reduced to cover only the NE Atlantic and Western Europe but this is sufficient to show the major differences.

For the case of 12 GMT 11/12/78 (figure 1), a depression near ship 'C' (52.5N, 35.5W) was badly analysed without the ships, but the differences in the forecasts after 36 hours were small, and neither forecast was particularly good when compared with the verification. The largest differences occurred for the case of 00 GMT 23/12/78 (figure 4) when a depression near ship 'R' (47N, 17W) was analysed at 982mb with the ships, but at 999mb without. This led to major differences in the forecasts, with a completely erroneous forecast being produced from the analysis without the weather ships. The case of 12 GMT 23/12/78 was essentially a result of the differences from 00 GMT being propagated through the background fields, but the resulting forecasts were similar and would have given reasonable guidance.

The cases of 00 GMT 13/12/78 and 00 GMT 17/12/78 are slightly different from the cases mentioned above. In the former the analysis without weather ships produced a pronounced ridge near ship 'R' which was less intense when that ship was included. However, the hand drawn chart has no ridge simply because the analyst believed ship 'R' and ignored a neighbouring ship reporting a much higher pressure. This enabled the intervener to eliminate this erroneous observation from the operational analysis (not shown) which then produced a pressure field similar to the hand drawn chart. Similarly, in the case of 00 GMT 17/12/78 a small depression near ship 'C' was not analysed properly by either analysis, but the information from ship 'C' enabled the intervener to produce a much deeper depression (998mb) in the operational analysis, very similar to the hand drawn chart shown. Note the large differences in the forecasts to the NE of Iceland, the one produced from the analysis with

weather ships being superior.

5. Conclusions

The calculated r.m.s error values show that the inclusion of weather ship data leads to a small but definite improvement in the analyses and subsequent forecasts. However, such measures of error are misleading as they tend to mask the large differences that can occur in important individual cases. At least five such cases occurred during the period of this study (approx. 11%) and in one of these (00 GMT 23/12/78) the forecast without using weather ship data was seriously in error and would have given very poor guidance to the forecasters in a serious storm situation. In addition, the cases of 00 GMT 13/12/78 and 00 GMT 17/12/78 demonstrate the worth of the ships in providing reference data against which to check other observations and to guide the human intervener.

6. Figures

The first 5 figures contain the analyses and 36 hour forecasts from the following datum times.

Figure 1 : 12 GMT 11/12/78

Figure 2 : 00 GMT 13/12/78

Figure 3 : 00 GMT 17/12/78

Figure 4 : 00 GMT 23/12/78

Figure 5 : 12 GMT 23/12/78

The figures include:

(i) The hand drawn charts of the Central Forecasting Office for the analysis and verification times.

(ii) The analysis and forecast charts for the case with weather ship data.

(iii) The analysis and forecast charts for the case without weather ship data.

The following rate of rainfall symbols are used on the forecast charts:

Frontal rain (Some dynamic rain F/C) * ⊙ ⊙ . = total rate 4.0;0.5;0.1;0.01 mm/hr

Showers (Nil sign dynamic rain) ▽ v . = local convective rate 4.0;0.5;0.1 mm/hr

Pecked lines represent 20% and 80% possibility of snow.

The subsequent 36 figures contain the rectangle analyses for the 12 cases considered, each consisting of 3 versions:-

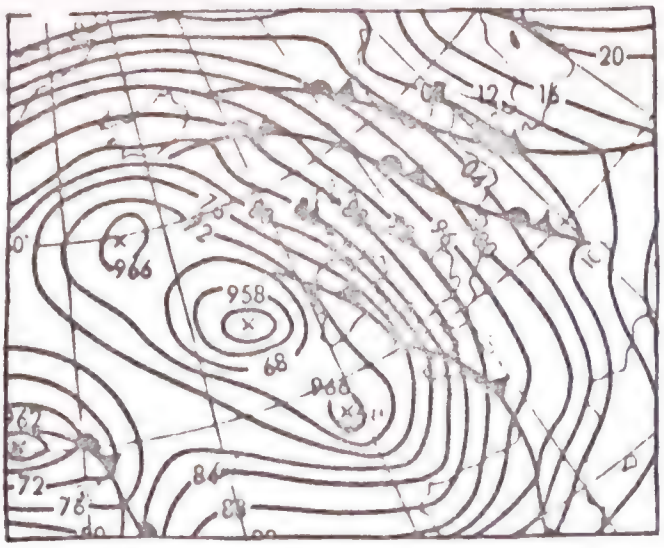
(i) Operational - with weather ships and intervention.

(ii) With weather ships but no intervention.

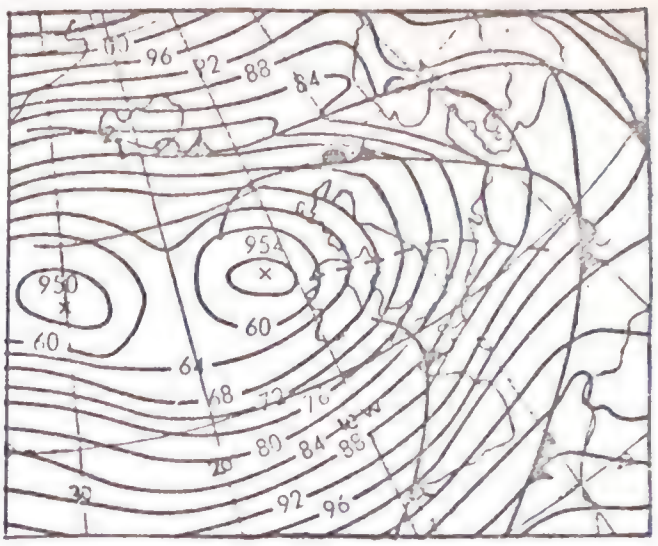
(iii) With neither weather ships nor intervention.

C.F.O HAND DRAWN CHARTS

12 GMT 11.12.78

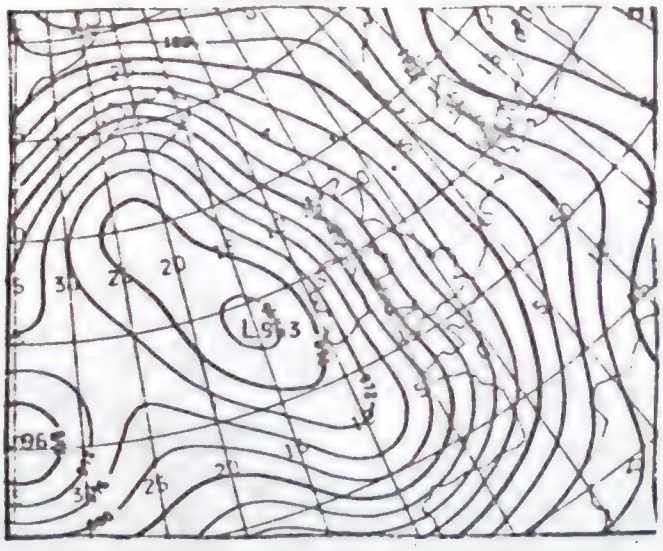


00 GMT 13.12.78

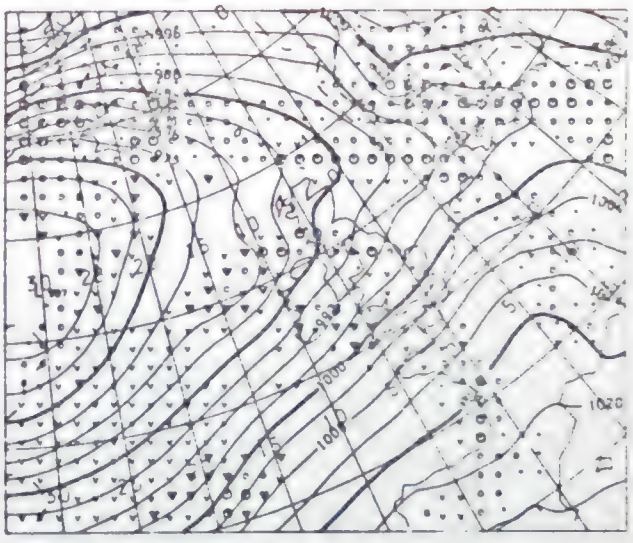


WITH WEATHER SHIPS

ANALYSIS

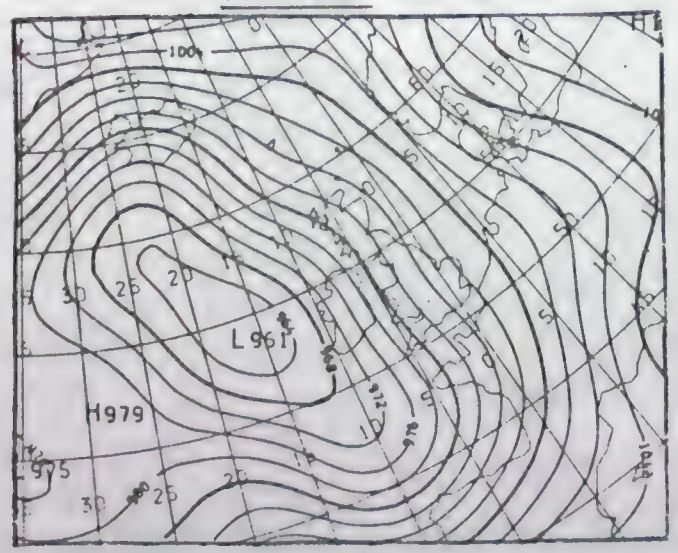


FORECAST



WITHOUT WEATHER SHIPS

ANALYSIS



FORECAST

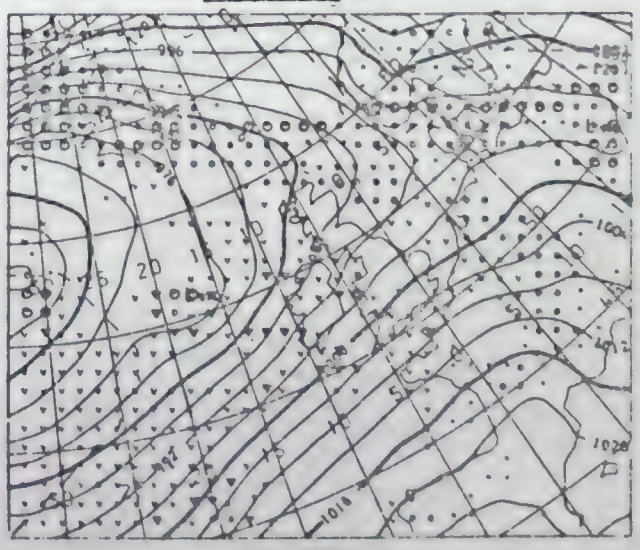
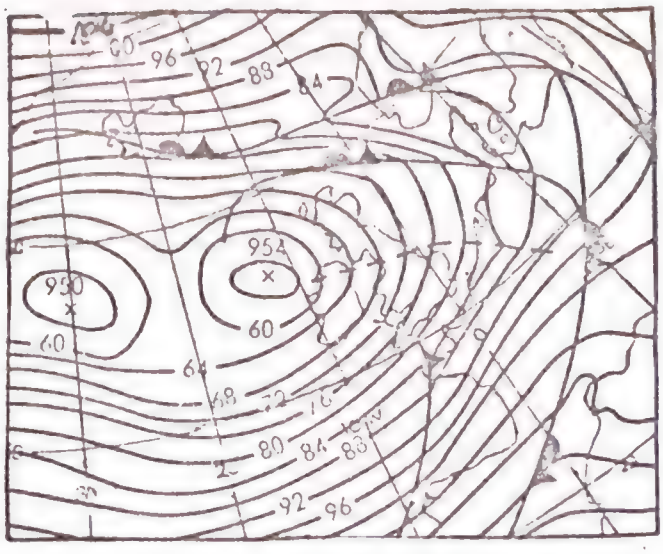


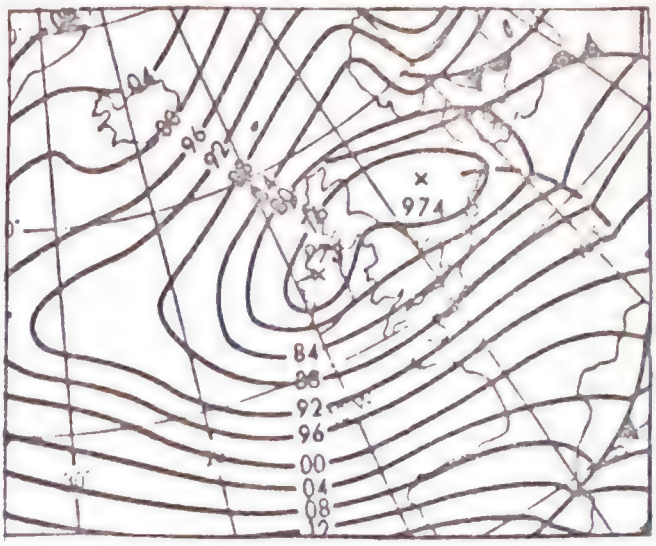
FIGURE 1

C.F.O HAND DRAWN CHARTS

00 GMT . 13.12.78

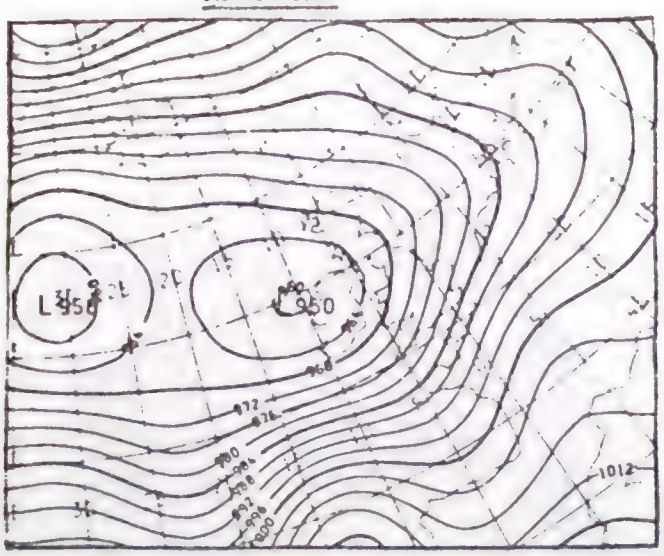


12 GMT 14.12.78

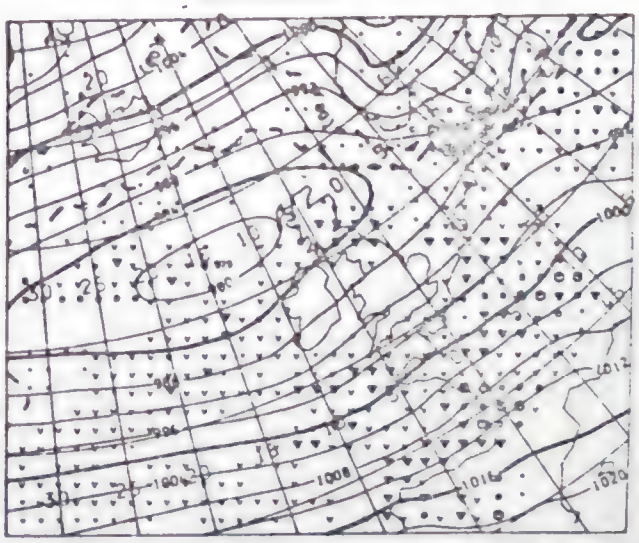


WITH WEATHER SHIPS

ANALYSIS

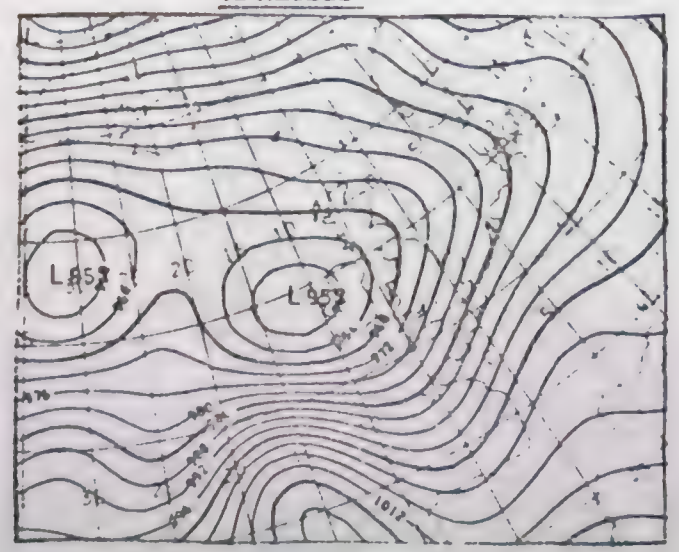


FORECAST



WITHOUT WEATHER SHIPS

ANALYSIS

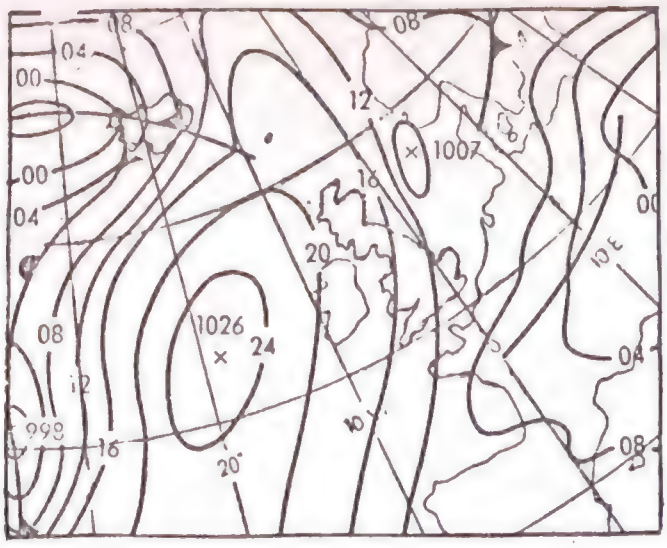


FORECAST

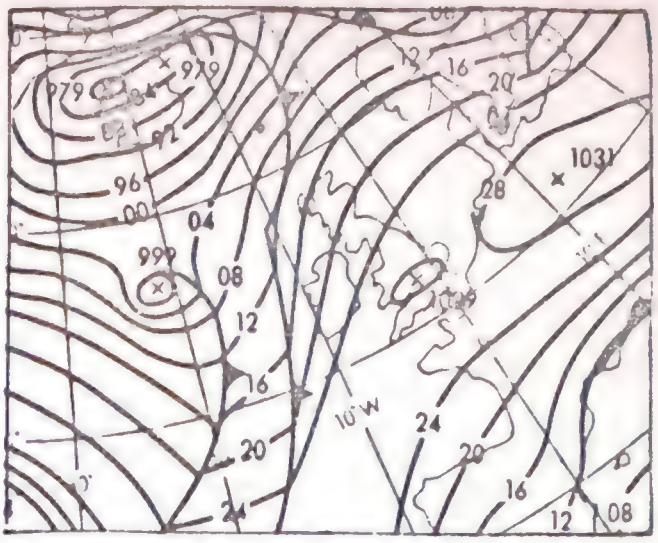
FIGURE 2

C.F.O HAND DRAWN CHARTS

00 GMT 17.12.78

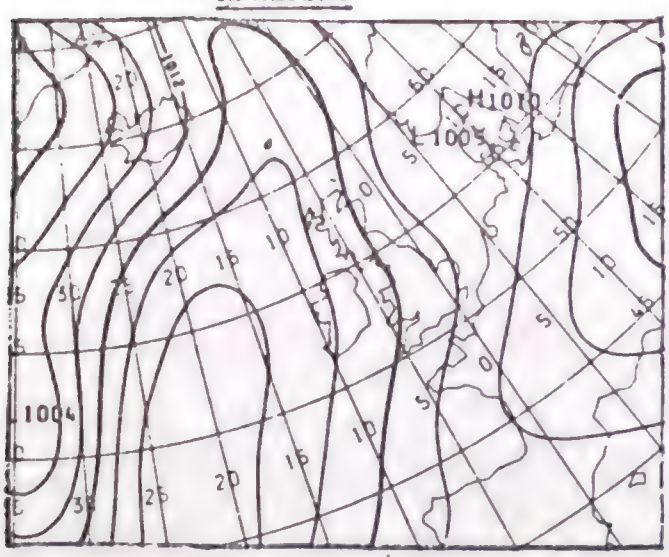


12 GMT 18.12.78

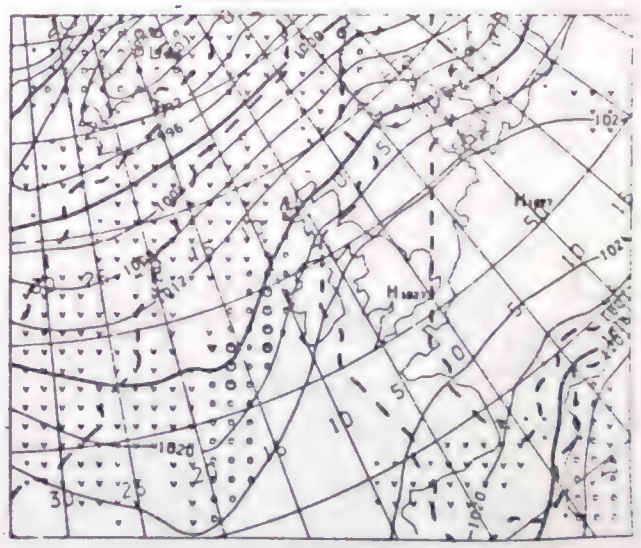


WITH WEATHER SHIPS

ANALYSIS

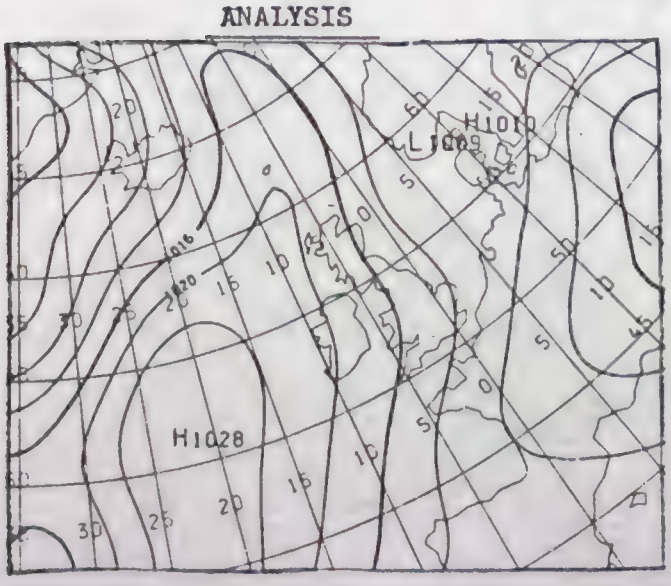


FORECAST



WITHOUT WEATHER SHIPS

ANALYSIS



FORECAST

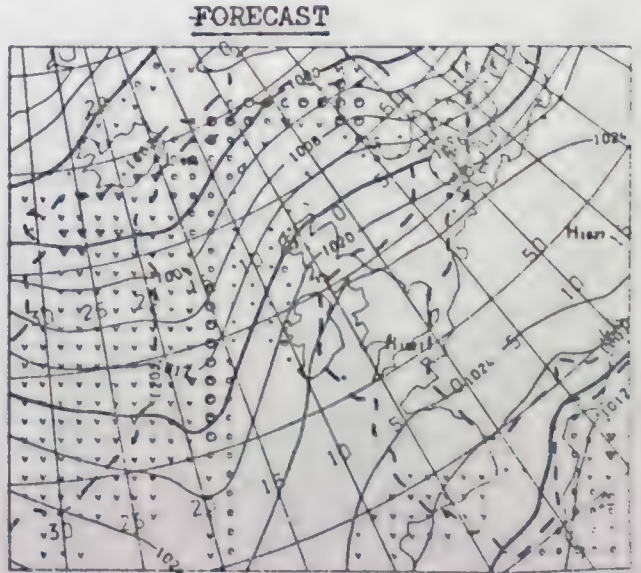
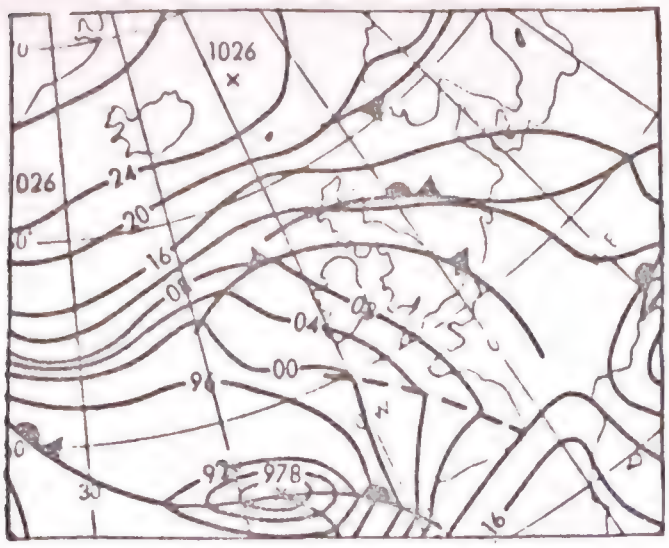


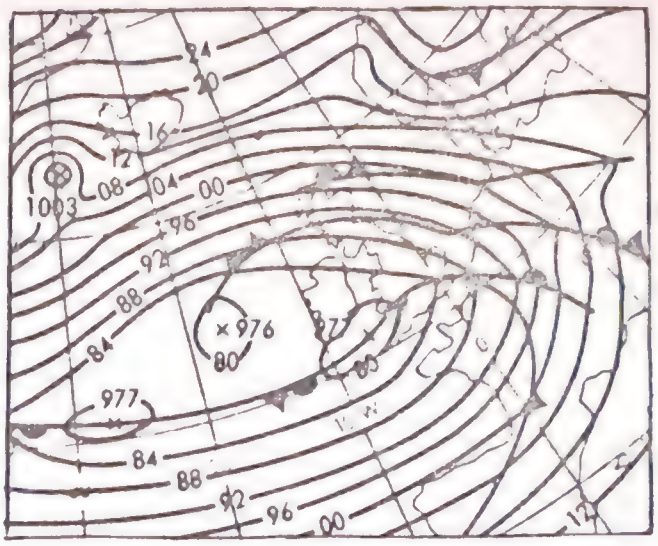
FIGURE 3

C.F.O HAND DRAWN CHARTS

00 GMT . 23.12.78

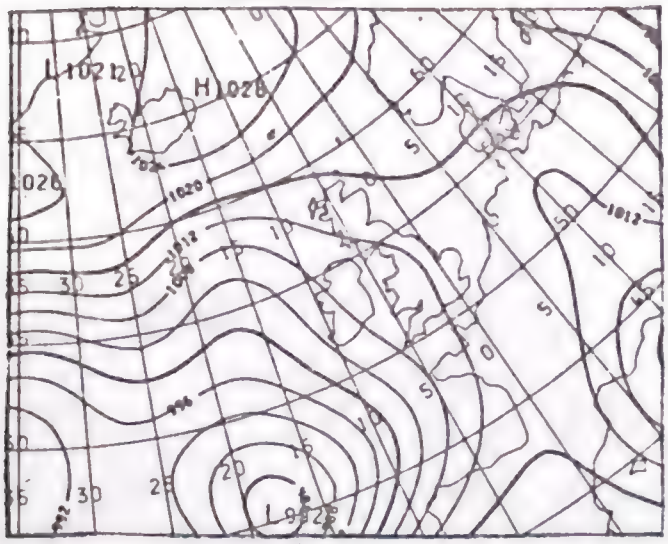


12 GMT 24.12.78

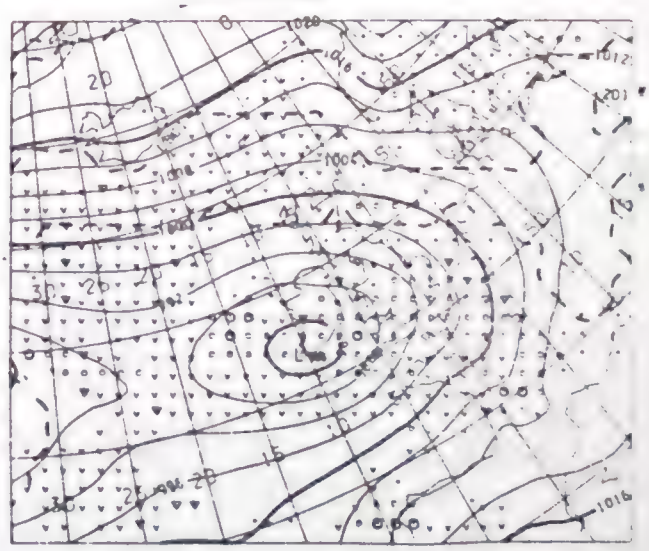


WITH WEATHER SHIPS

ANALYSIS

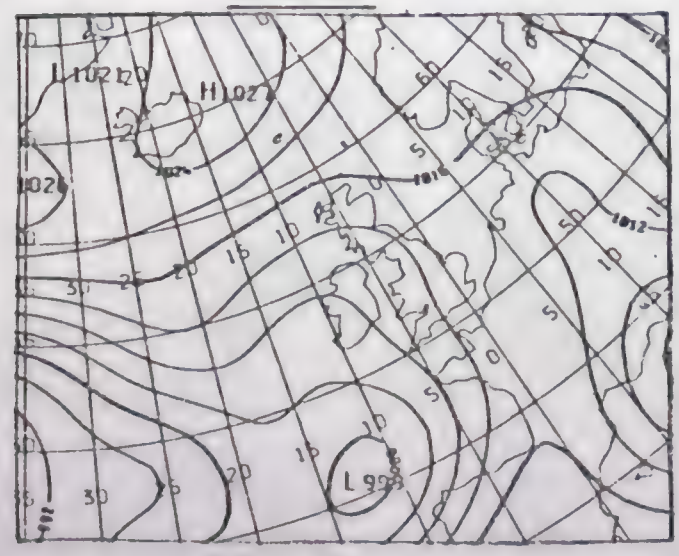


FORECAST



WITHOUT WEATHER SHIPS

ANALYSIS

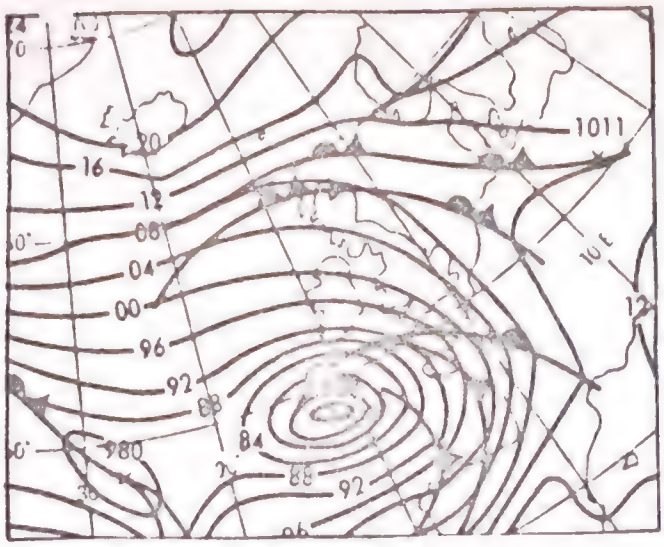


FORECAST

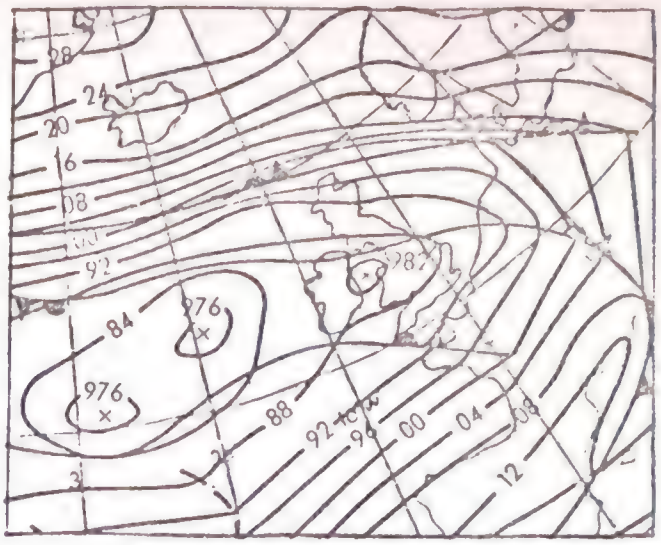
FIGURE 4

C.F.O HAND DRAWN CHARTS

12 GMT 23.12.78

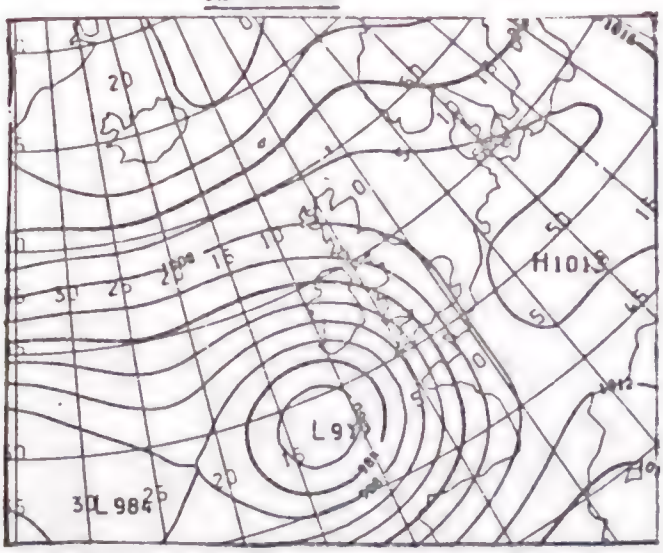


00 GMT 25.12.78

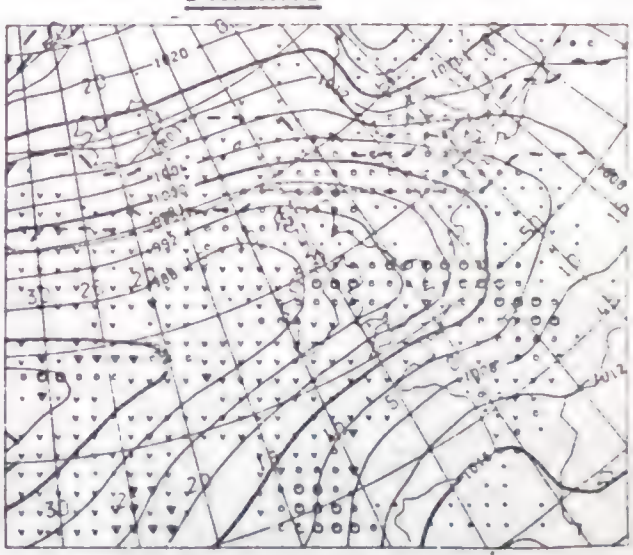


WITH WEATHER SHIPS

ANALYSIS

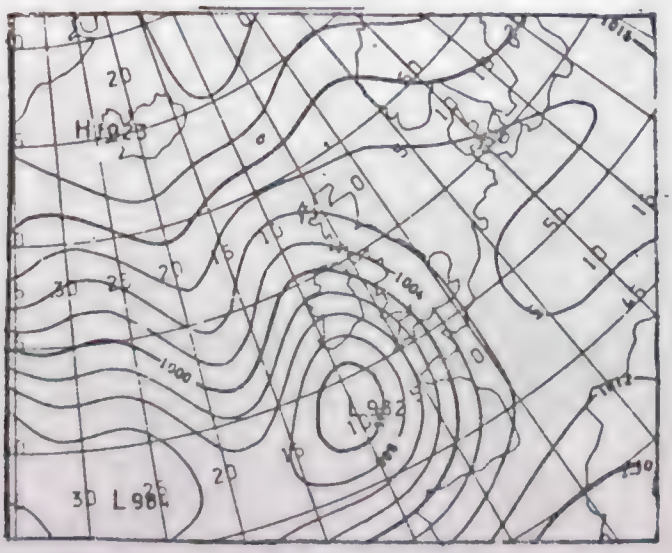


FORECAST



WITHOUT WEATHER SHIPS

ANALYSIS



FORECAST

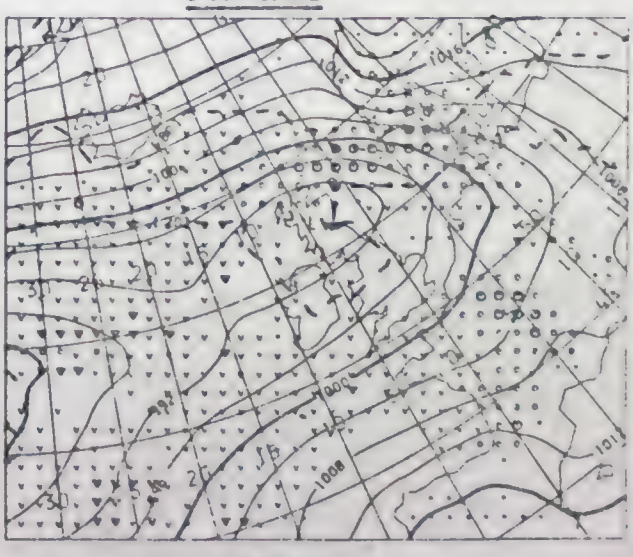


FIGURE 5

WITH WEATHER SHIPS

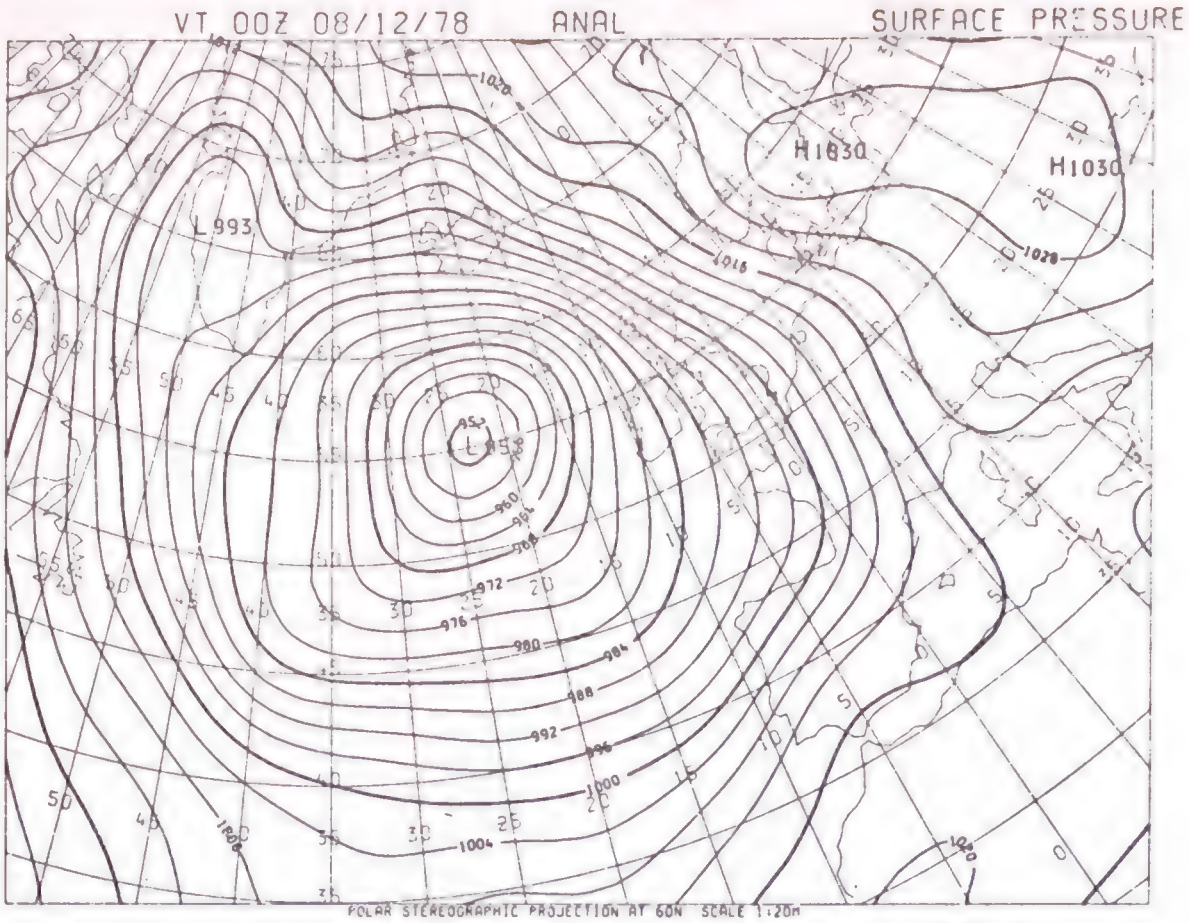


CHART 16

M02LLD1B

WITHOUT WEATHER SHIPS

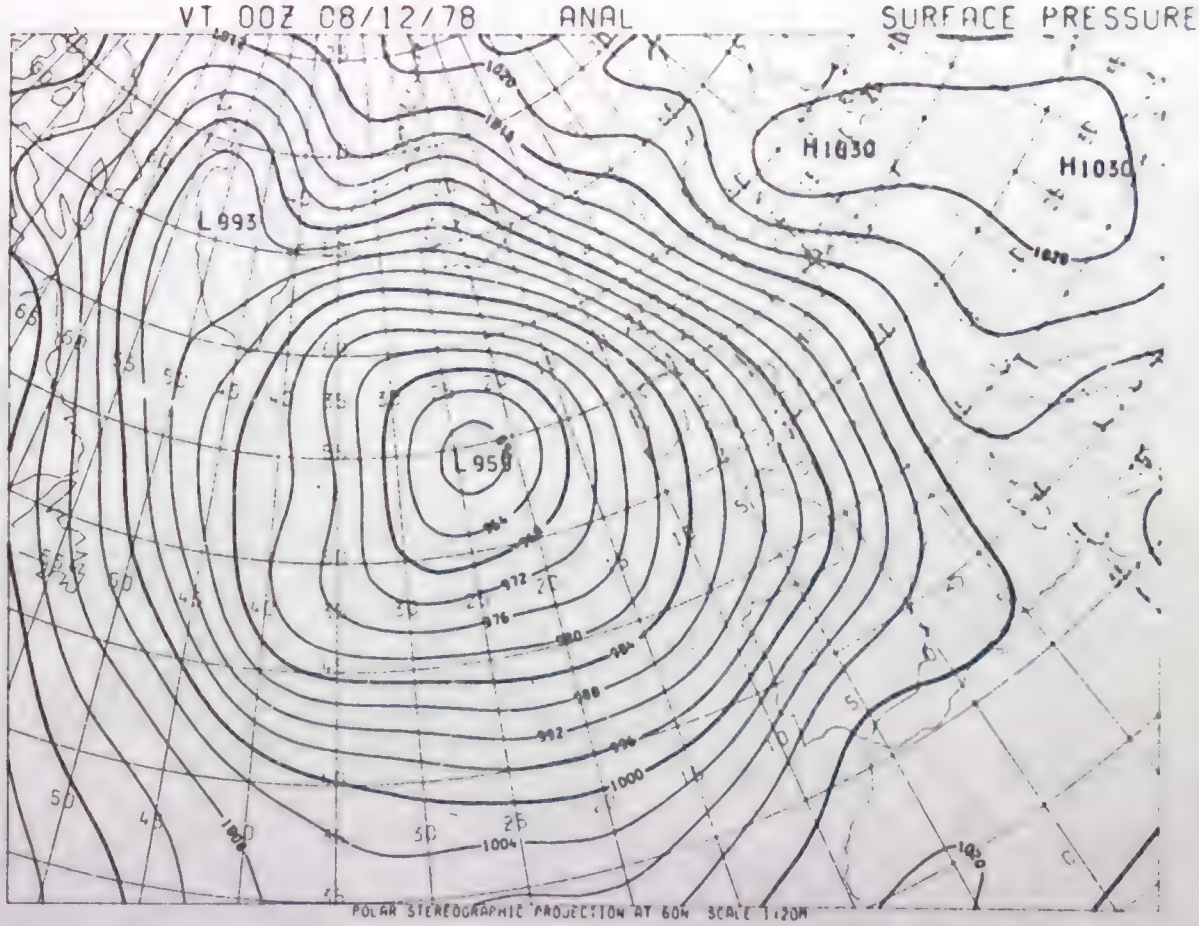
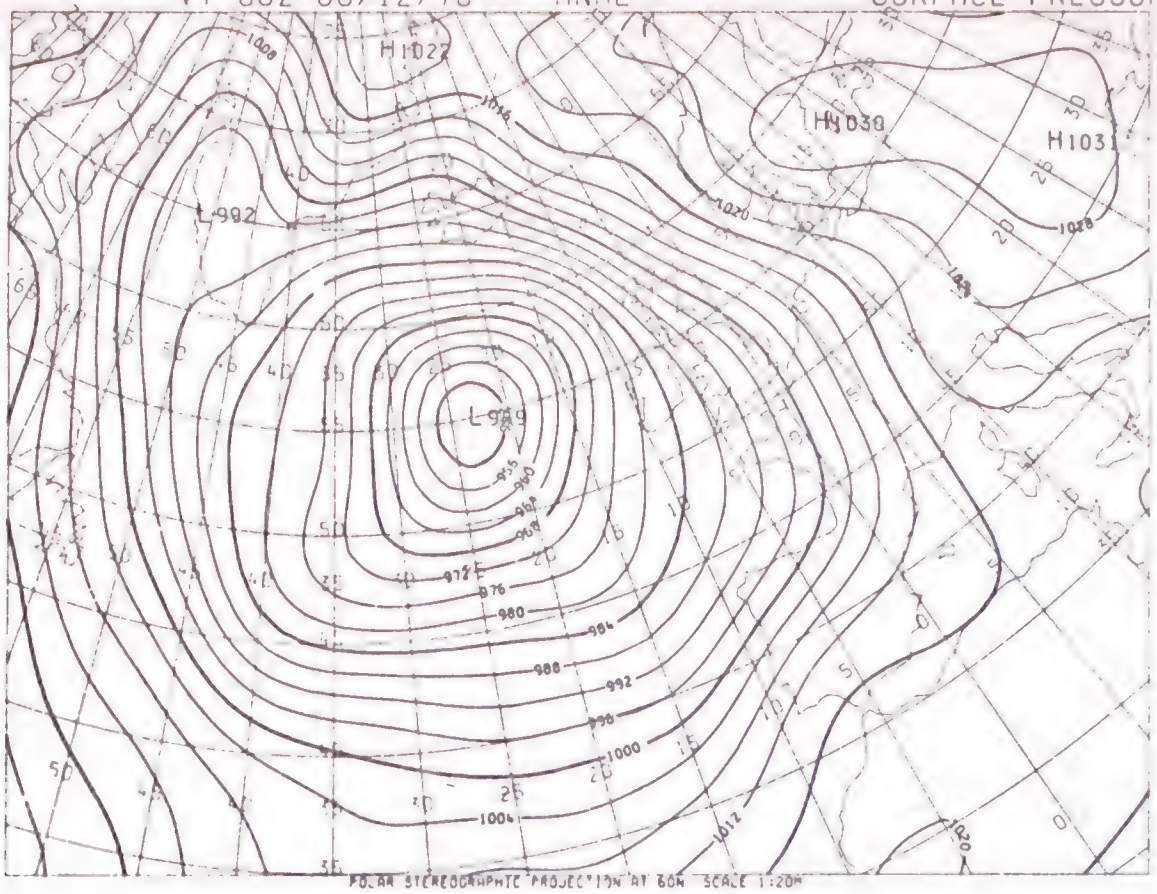


CHART 16

M02LLD1C

OPERATIONAL

VT 00Z 08/12/78 ANAL SURFACE PRESSURE



POLAR STEREOGRAPHIC PROJECTION AT 80N SCALE 1:20M

CHART 16

CFO

WITH WEATHER SHIPS

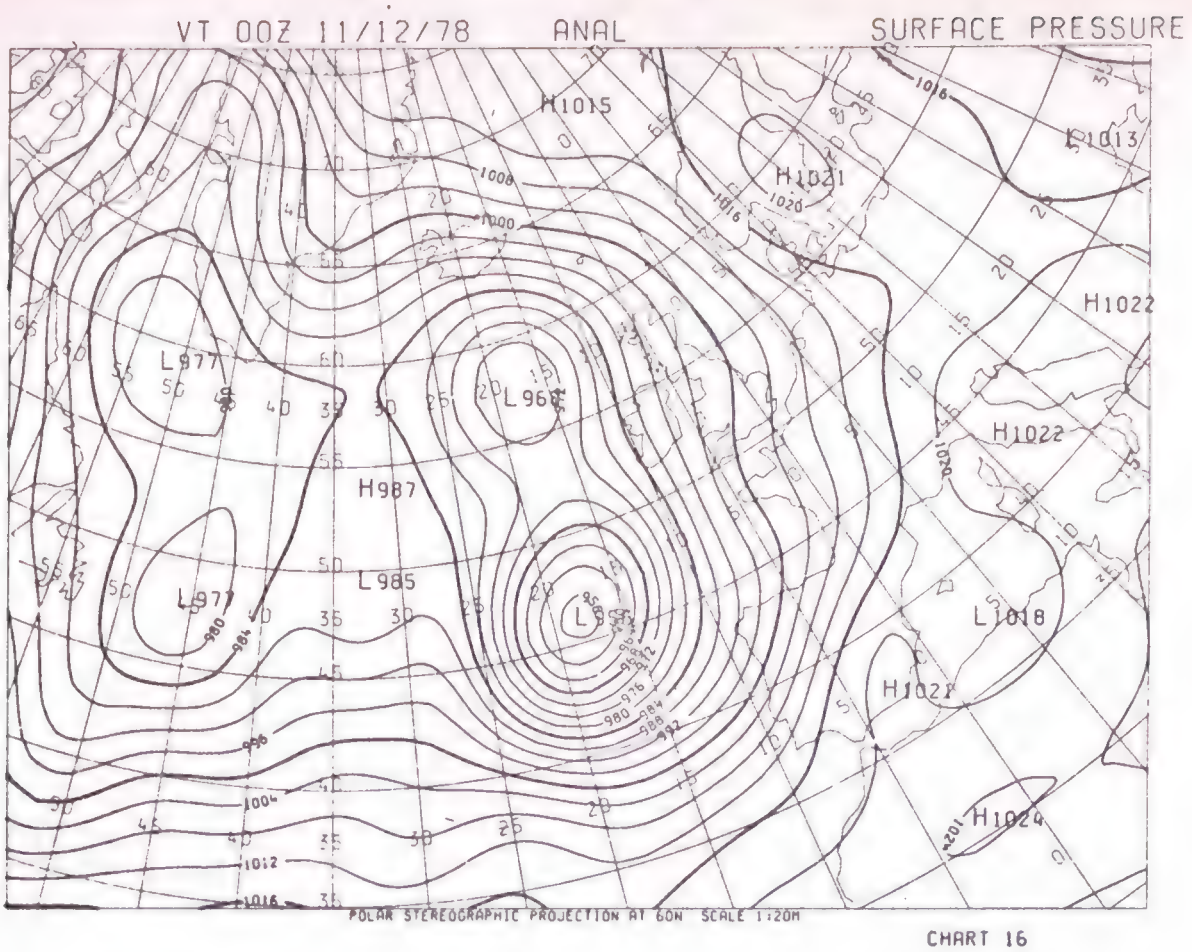


CHART 16

M02LLD1B

WITHOUT WEATHER SHIPS

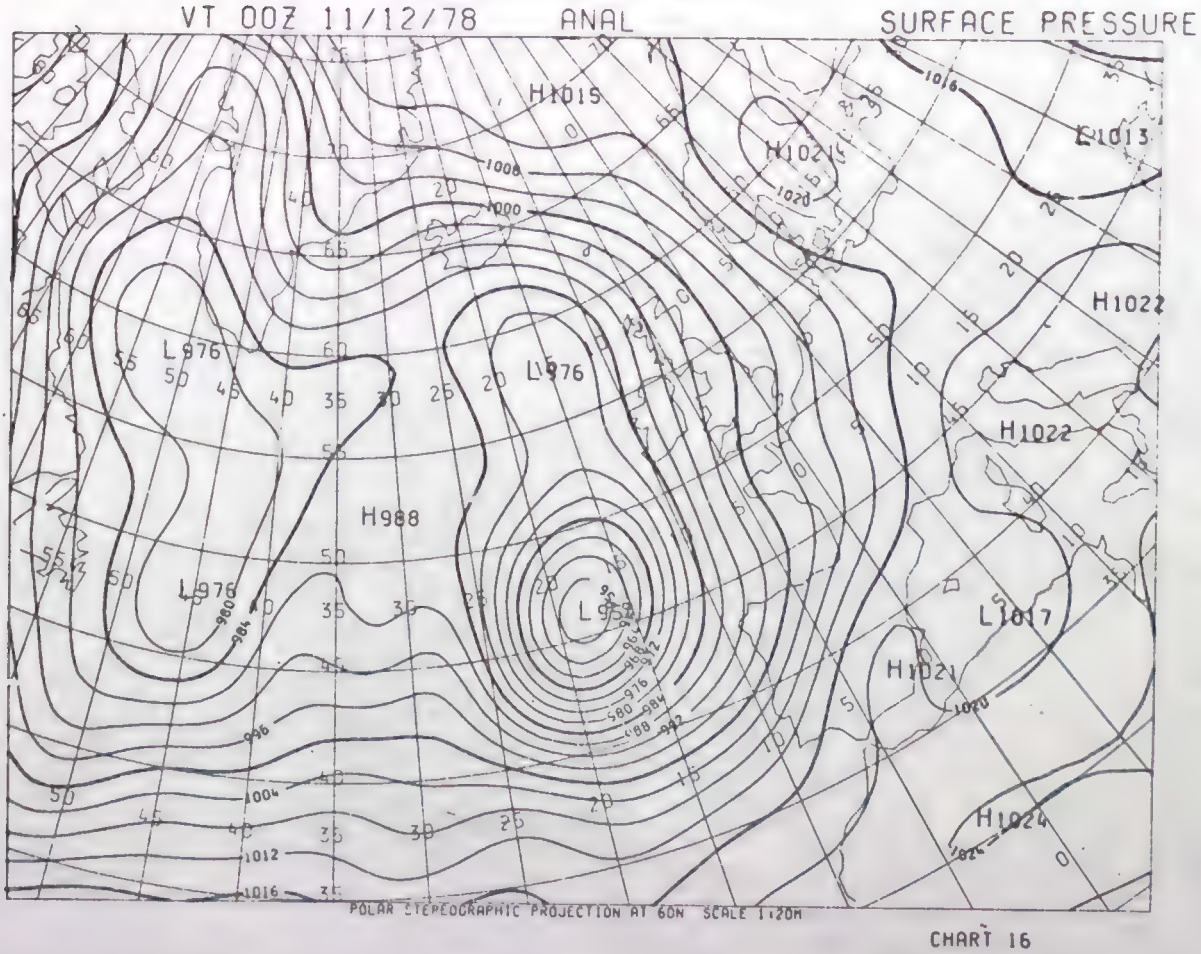


CHART 16

M02LLD1C

OPERATIONAL

VT 00Z 11/12/78 ANAL SURFACE PRESSURE

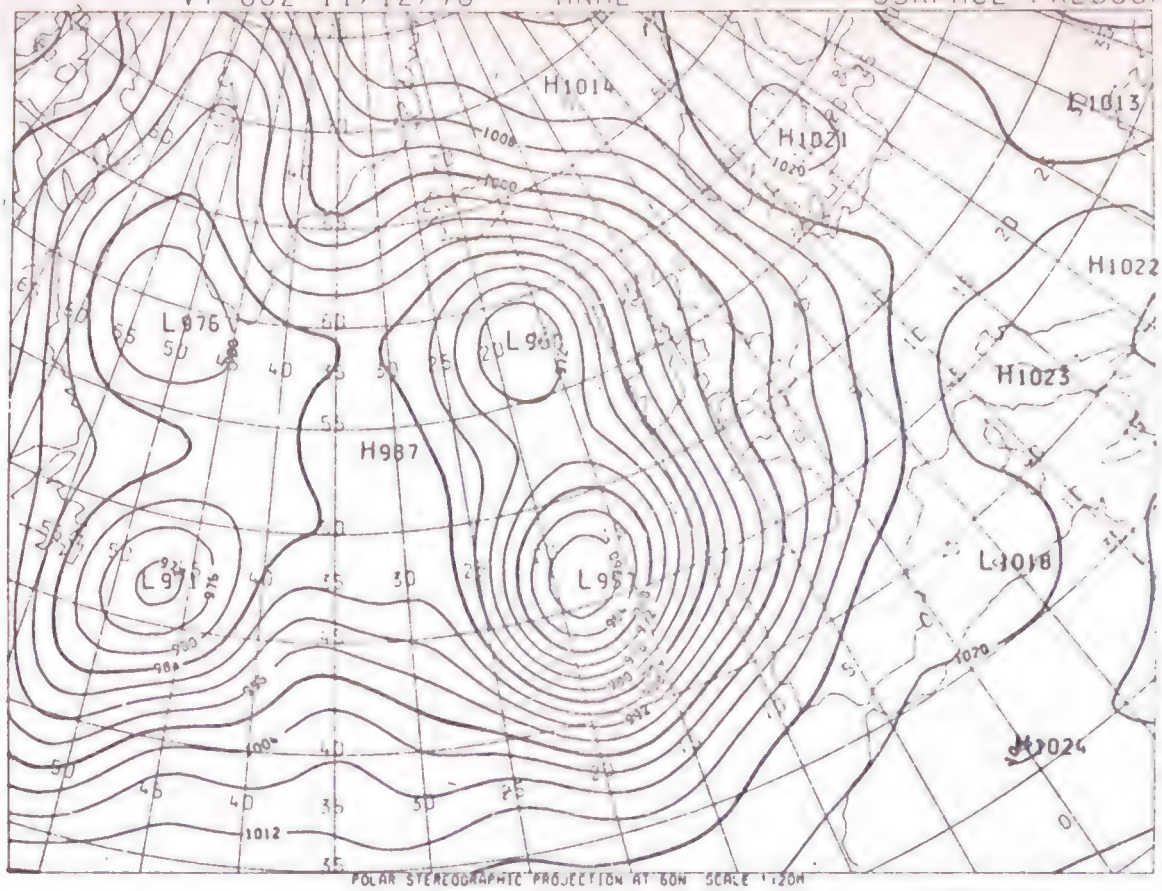


CHART 16

CFO

WITH WEATHER SHIPS

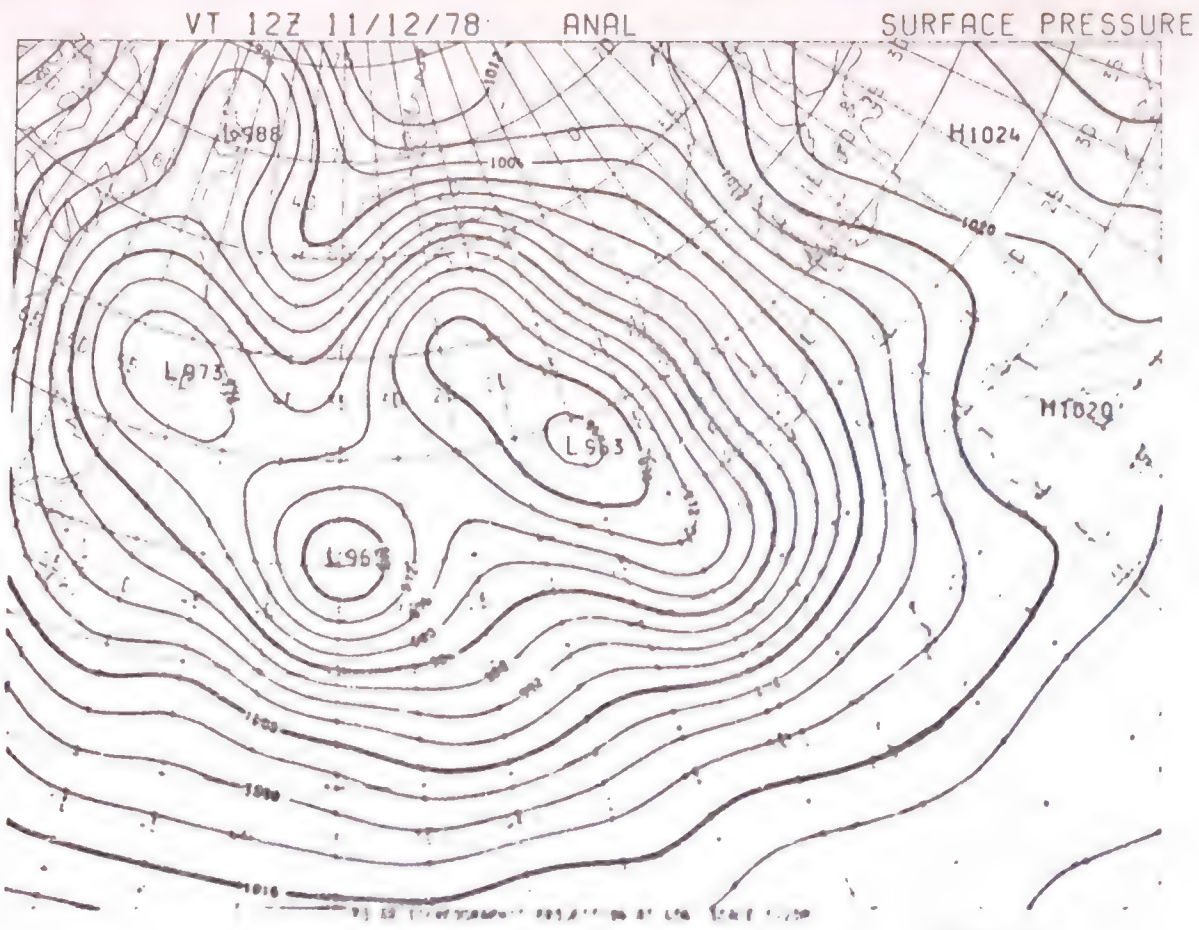


CHART 16
MO2LLD1B

WITHOUT WEATHER SHIPS

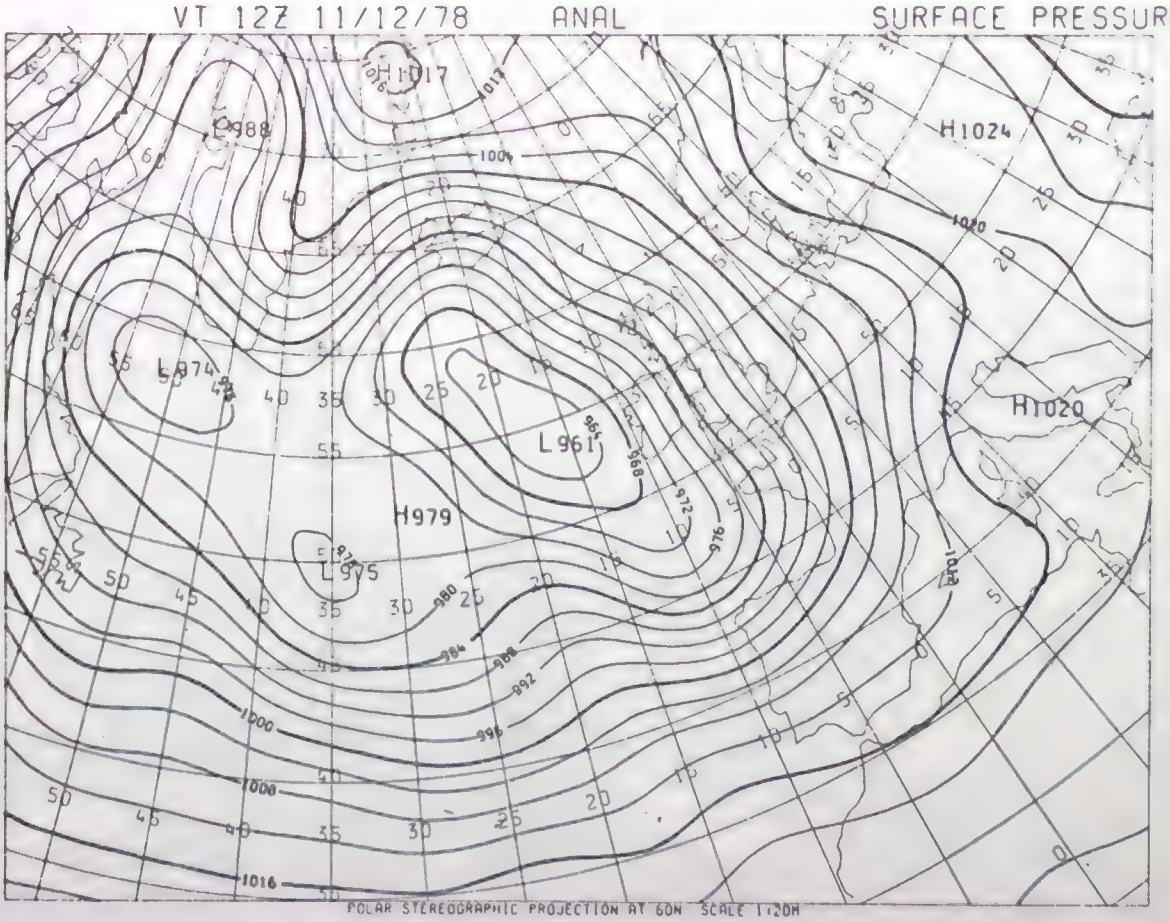
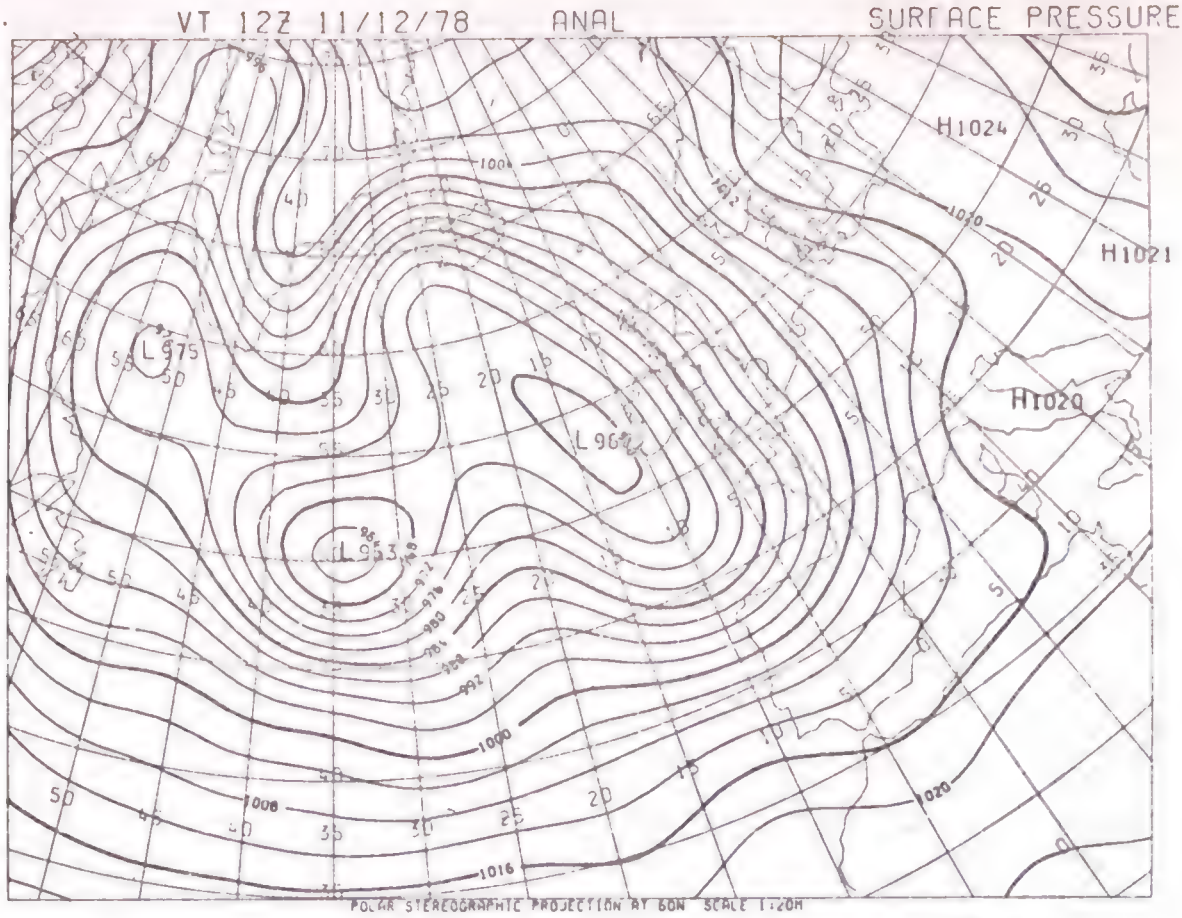


CHART 16
MO2LLD1C

OPERATIONAL

VT 12Z 11/12/78 ANAL SURFACE PRESSURE



POLAR STEREOGRAPHIC PROJECTION AT 60N SCALE 1:20M

CHART 16

CFO

WITH WEATHER SHIPS

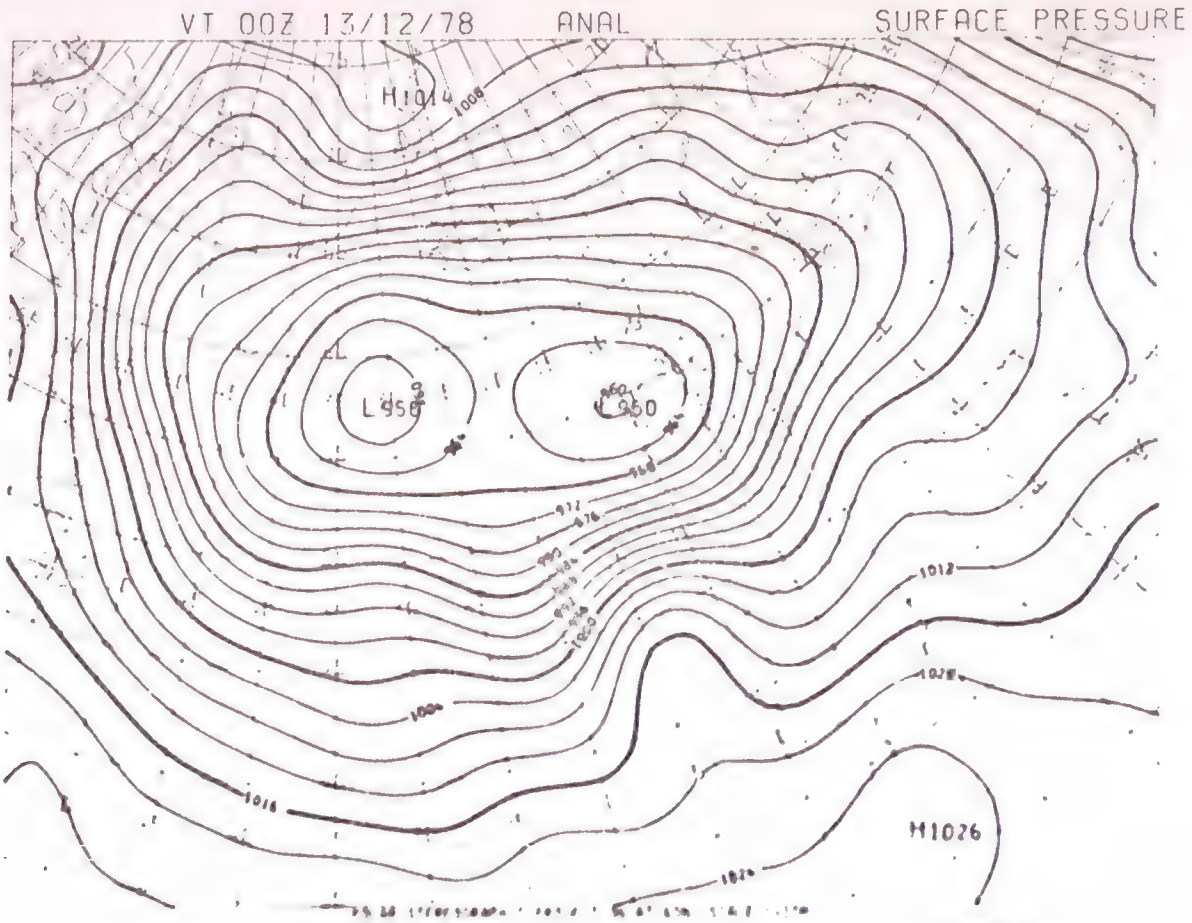


CHART 16
M02LLD1B

WITHOUT WEATHER SHIPS

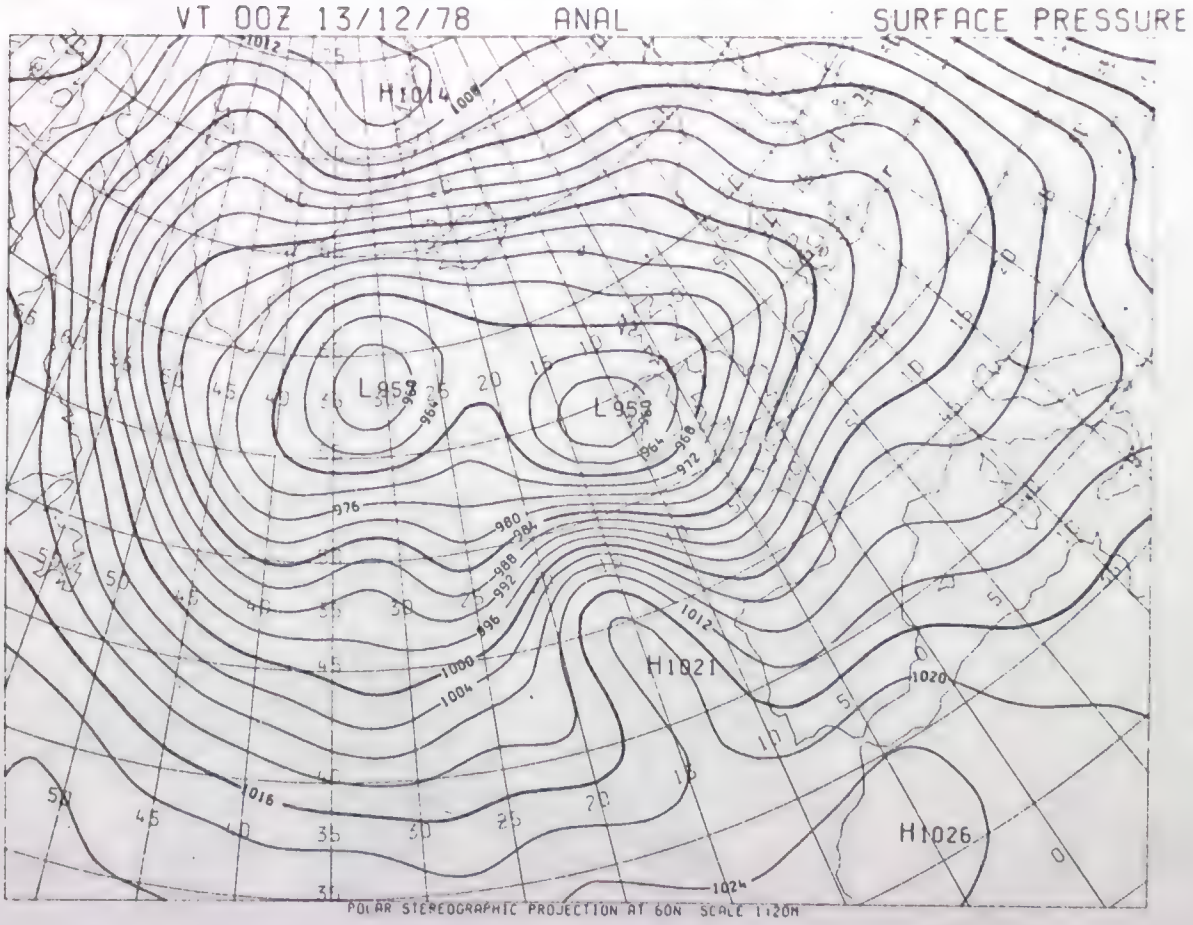


CHART 16
M02LLD1C

OPERATIONAL

VT 00Z 13/12/78 ANAL SURFACE PRESSURE

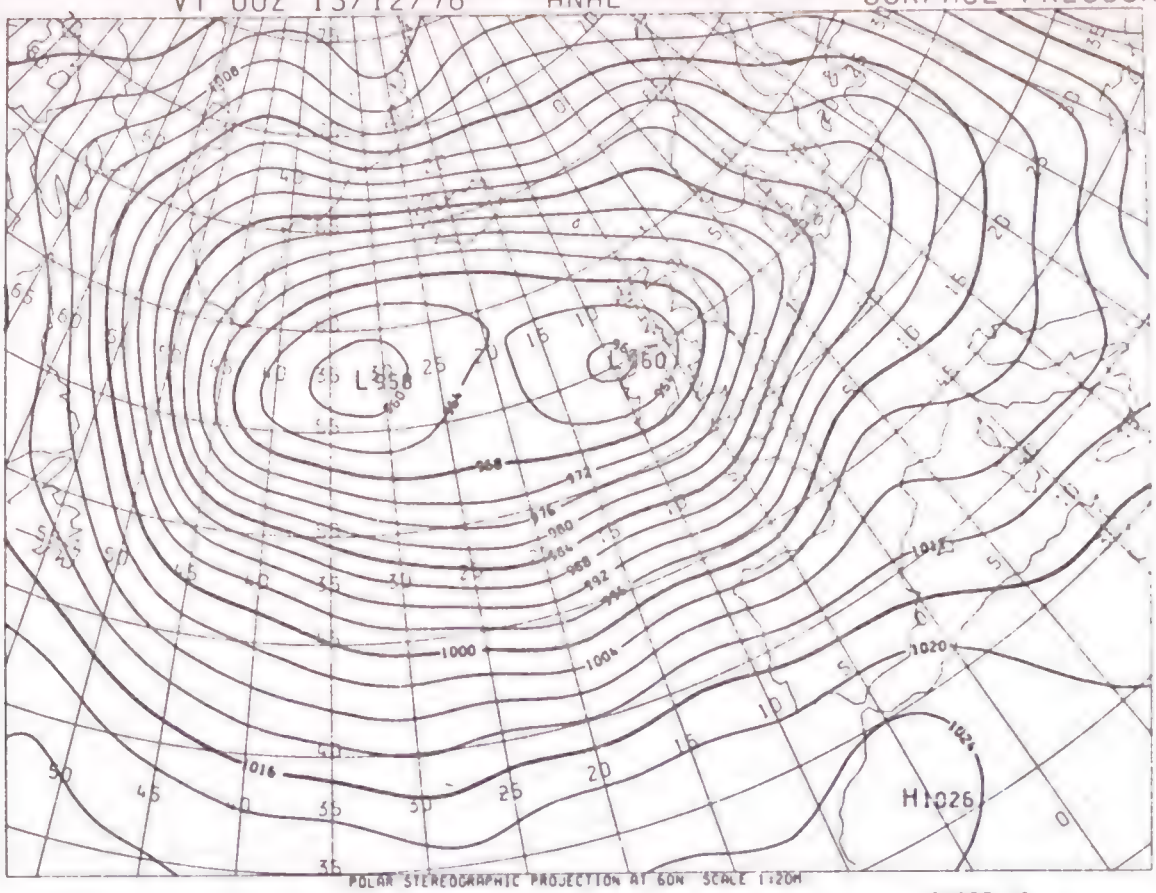


CHART 16

CFO

WITH WEATHER SHIPS

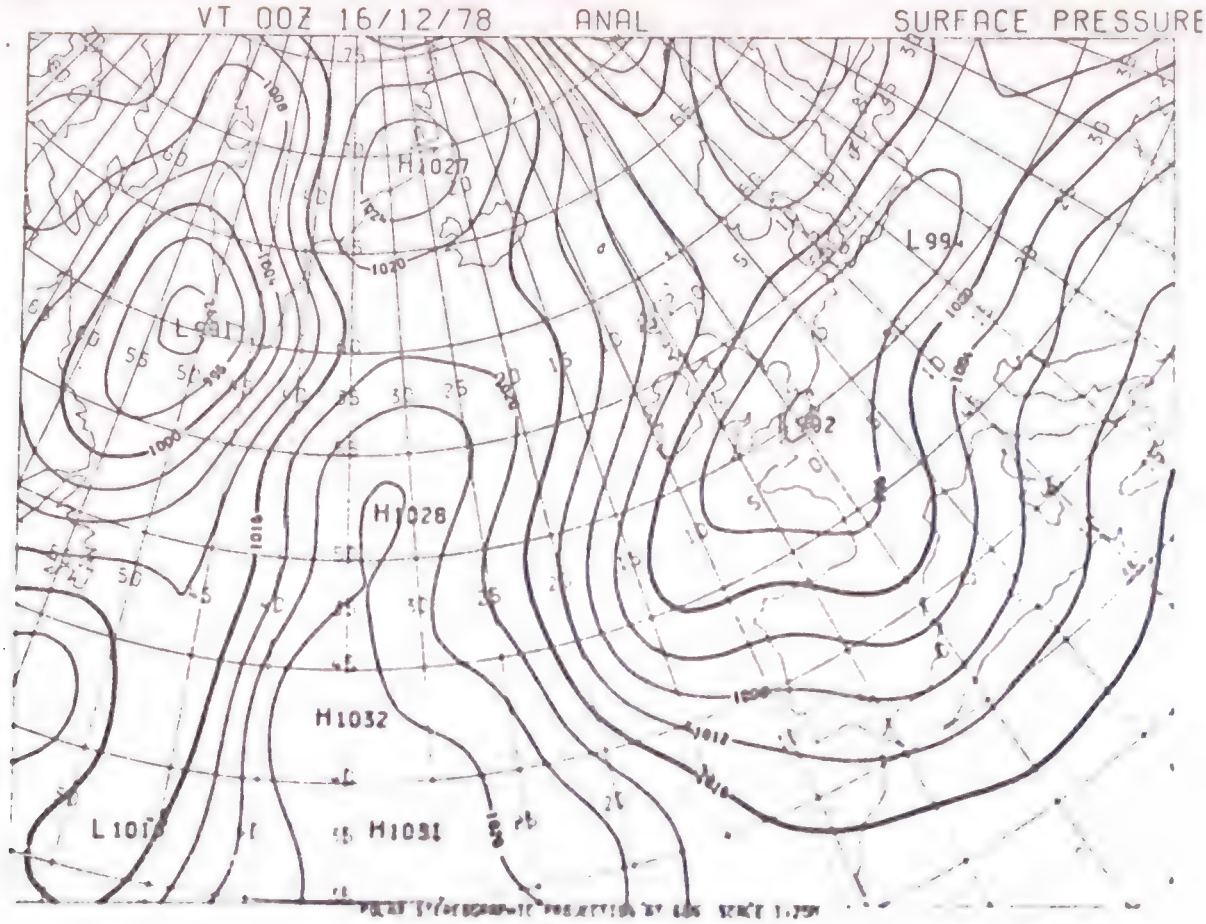


CHART 16

M02LL01B

WITHOUT WEATHER SHIPS

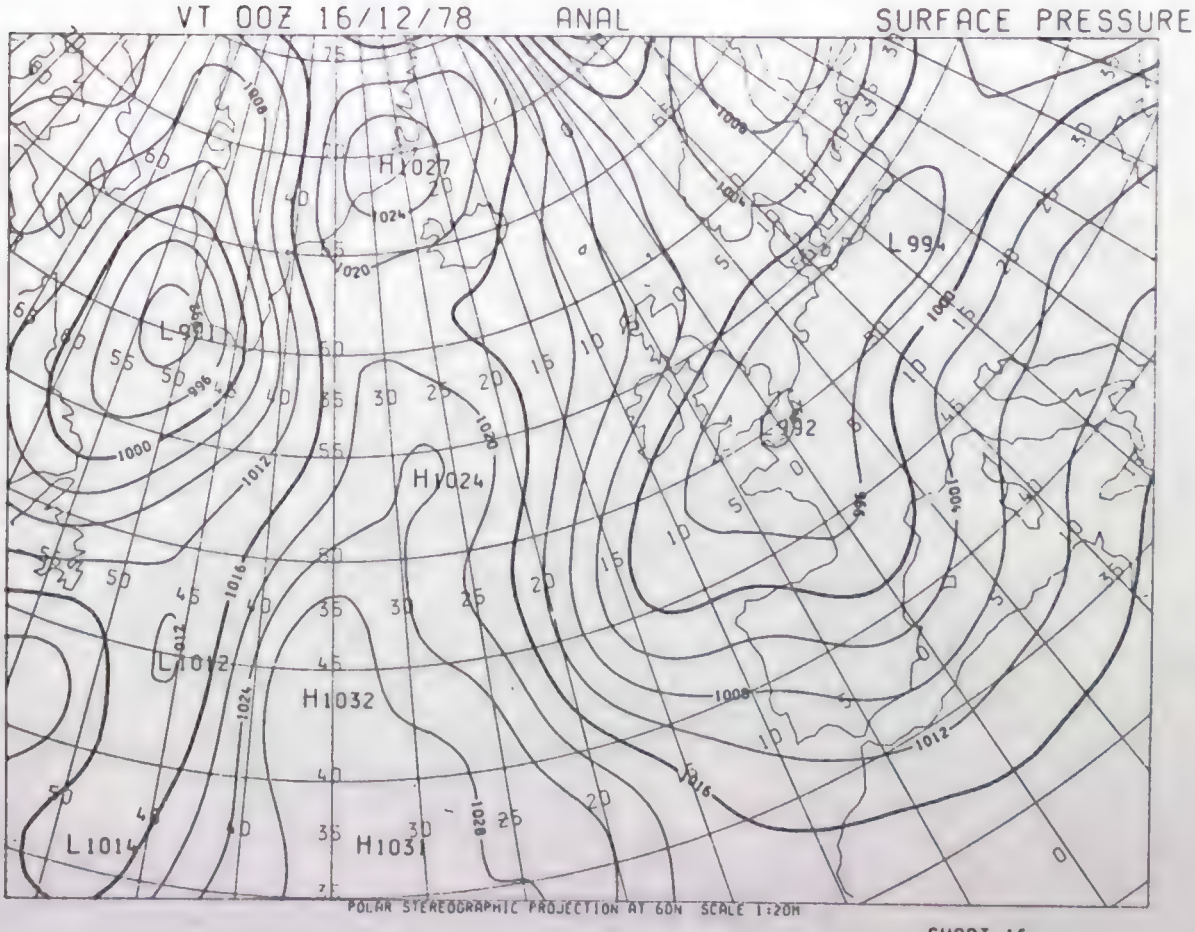


CHART 16

M02LL01C

WITH WEATHER SHIPS

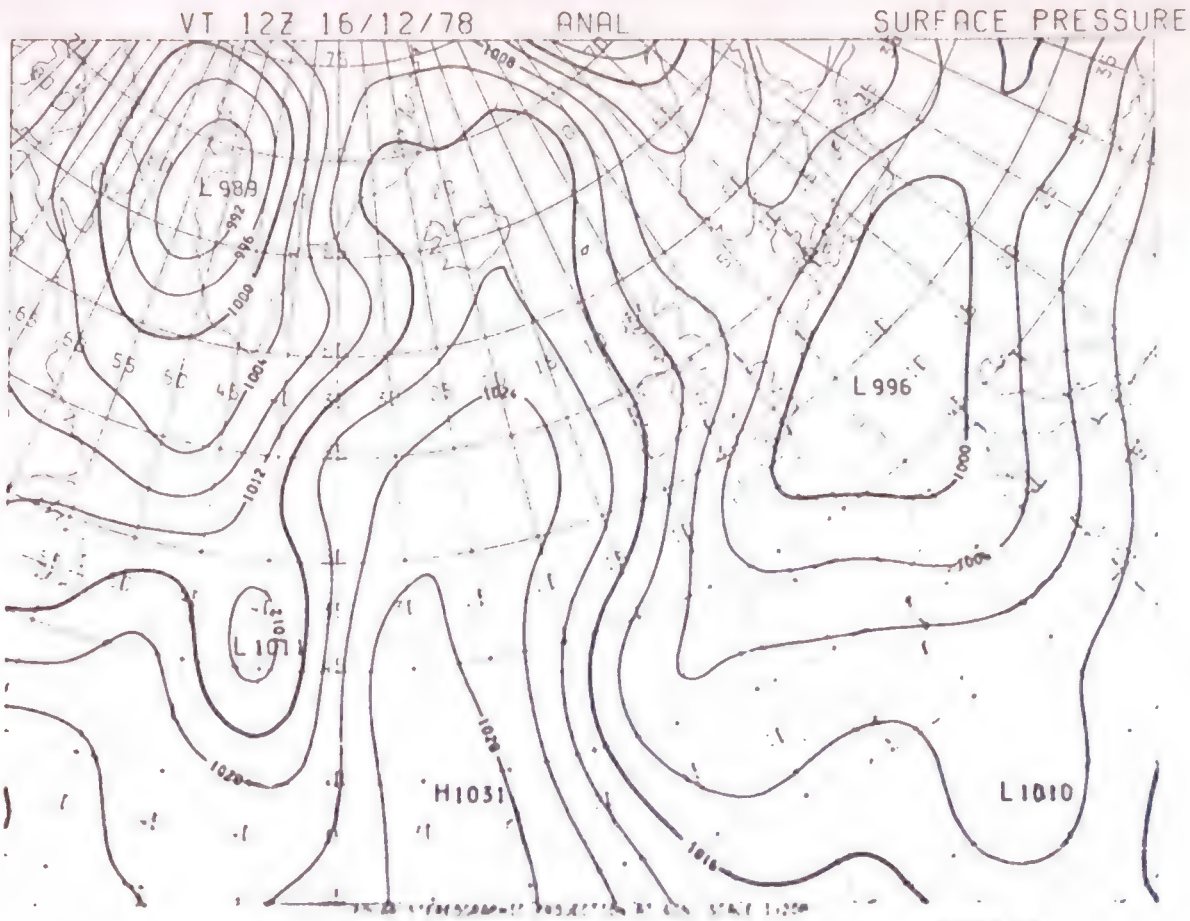


CHART 16
M02LLD1B

WITHOUT WEATHER SHIPS

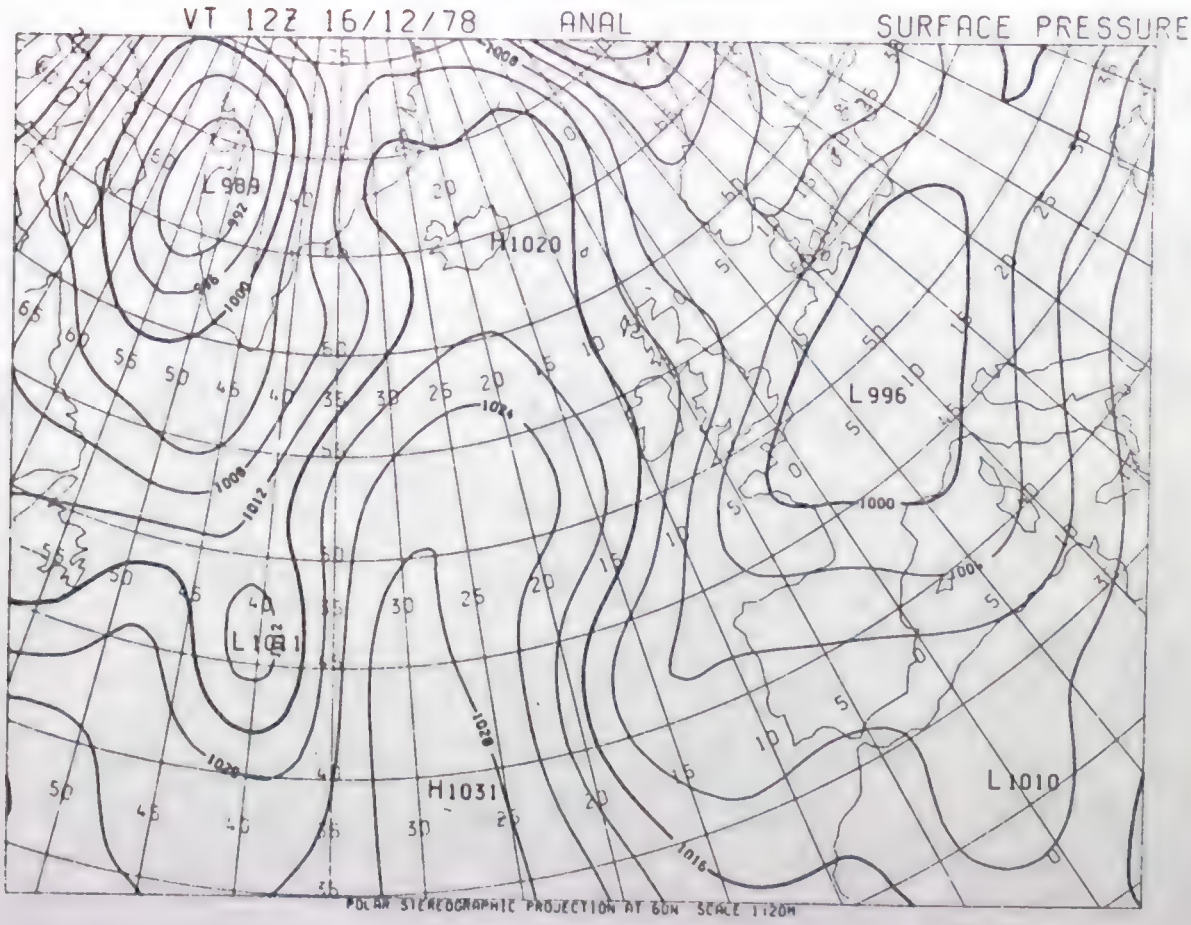
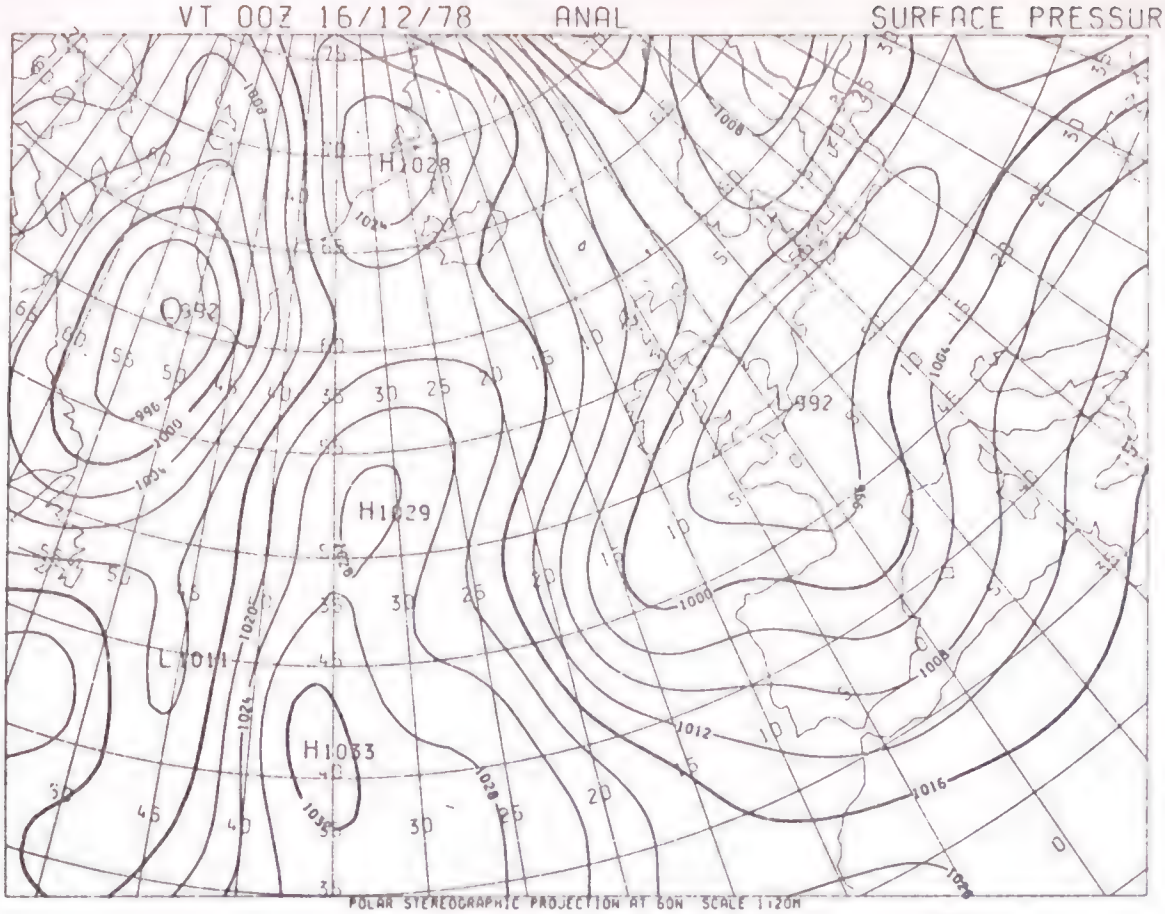


CHART 16
M02LLD1C

OPERATIONAL

VT 00Z 16/12/78 ANAL SURFACE PRESSURE



POLAR STEREOGRAPHIC PROJECTION AT 60N SCALE 1:20M

CHART 16

CFC

OPERATIONAL

VT 12Z 16/12/78 ANAL SURFACE PRESSURE

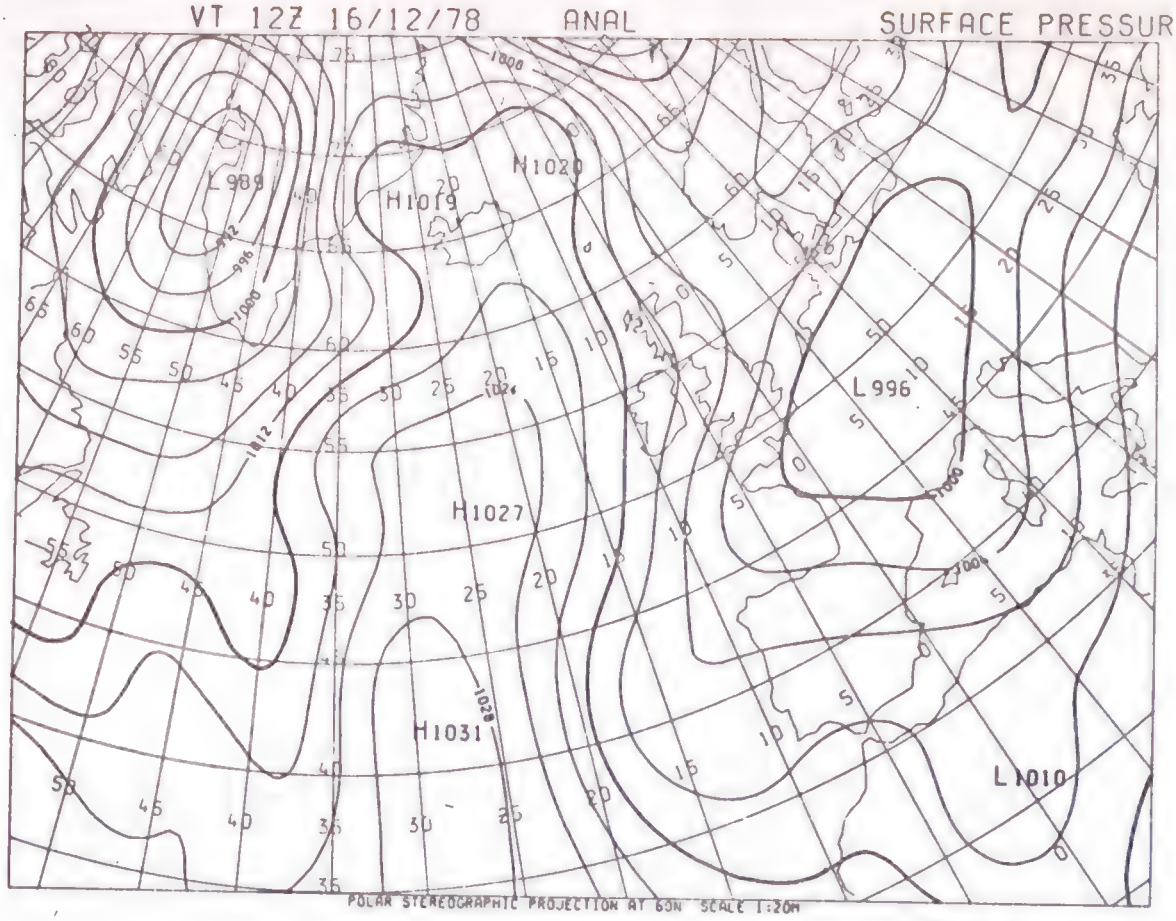


CHART 16

CFO

WITH WEATHER SHIPS

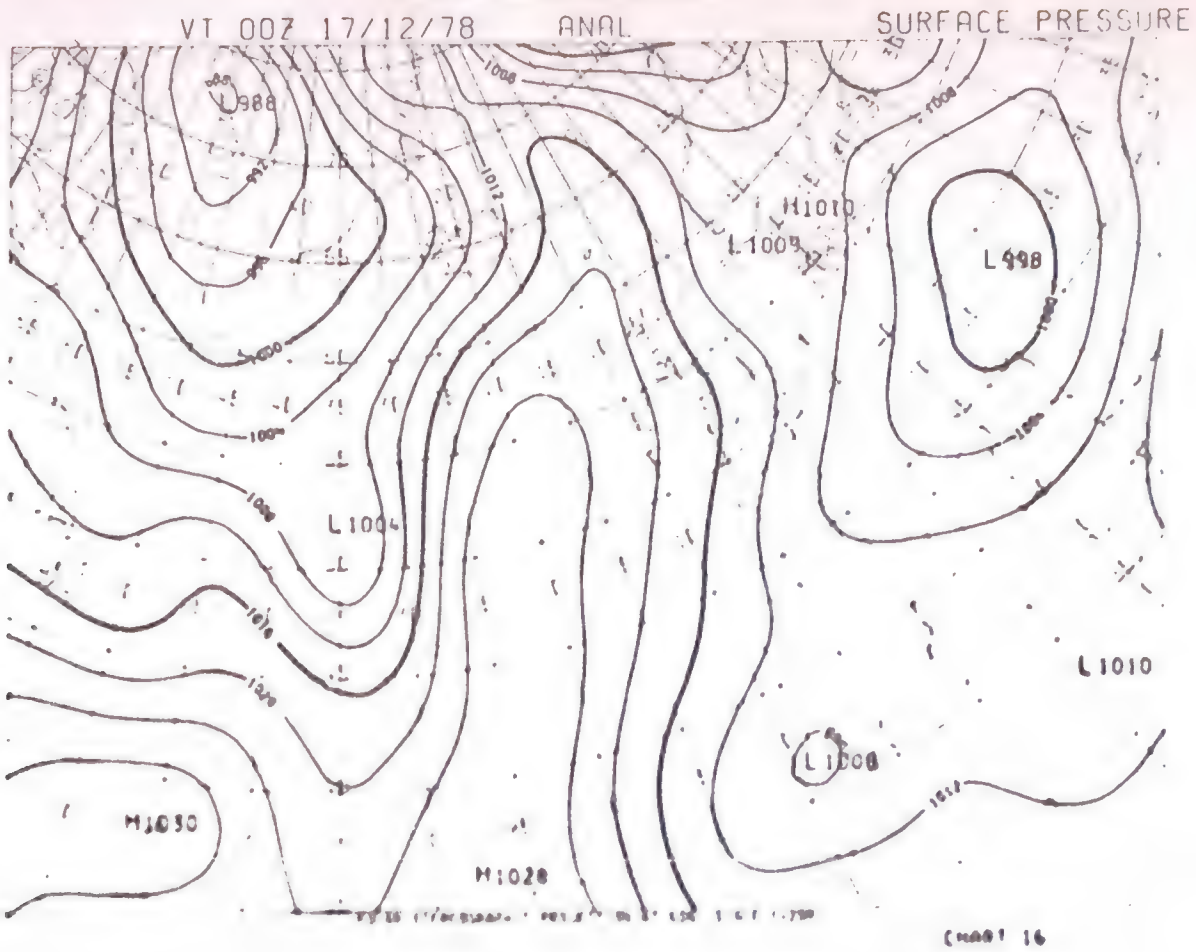


CHART 16
MO2LLD1B

WITHOUT WEATHER SHIPS

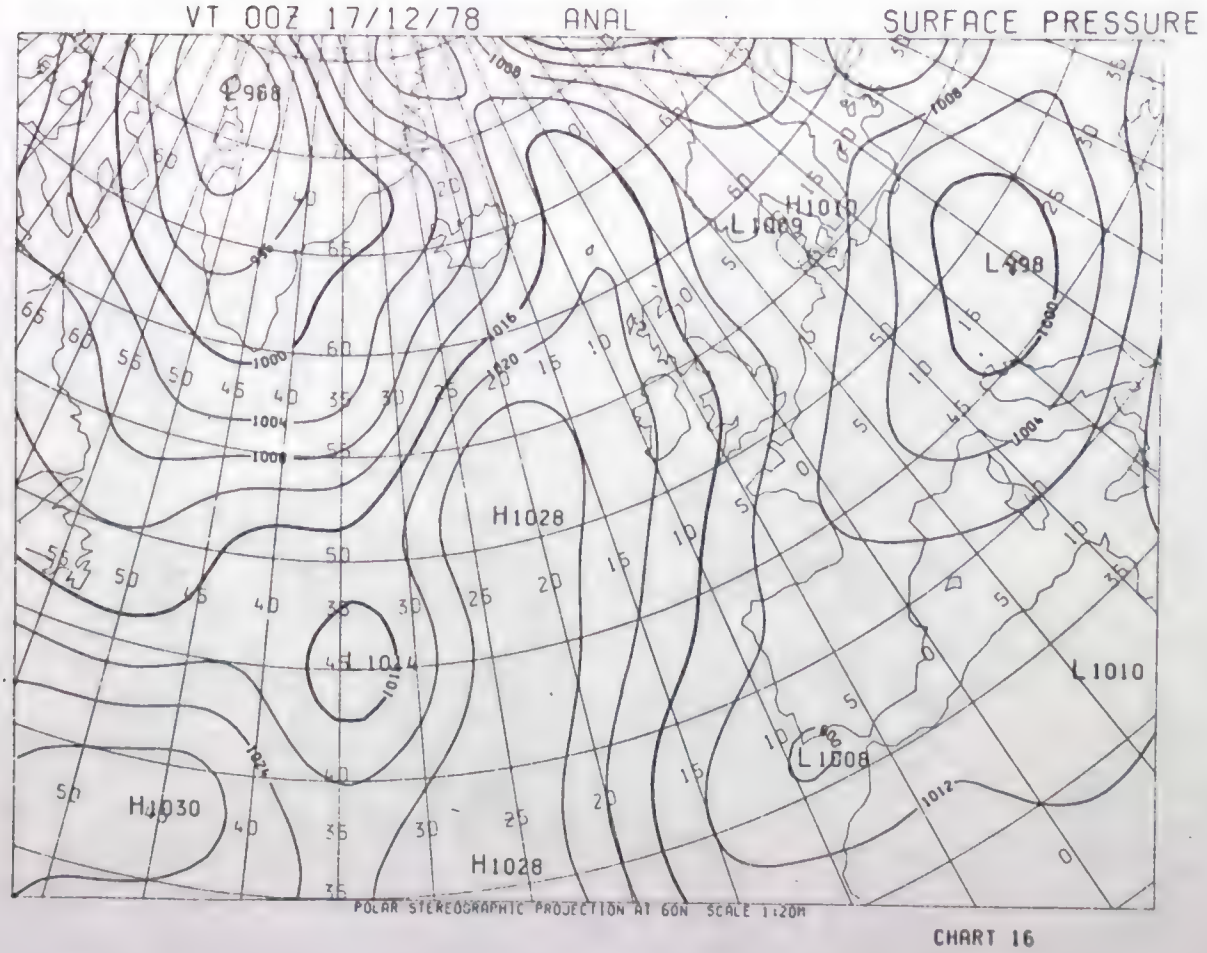


CHART 16
MO2LLD1C

OPERATIONAL

VT 00Z 17/12/78 ANAL SURFACE PRESSURE

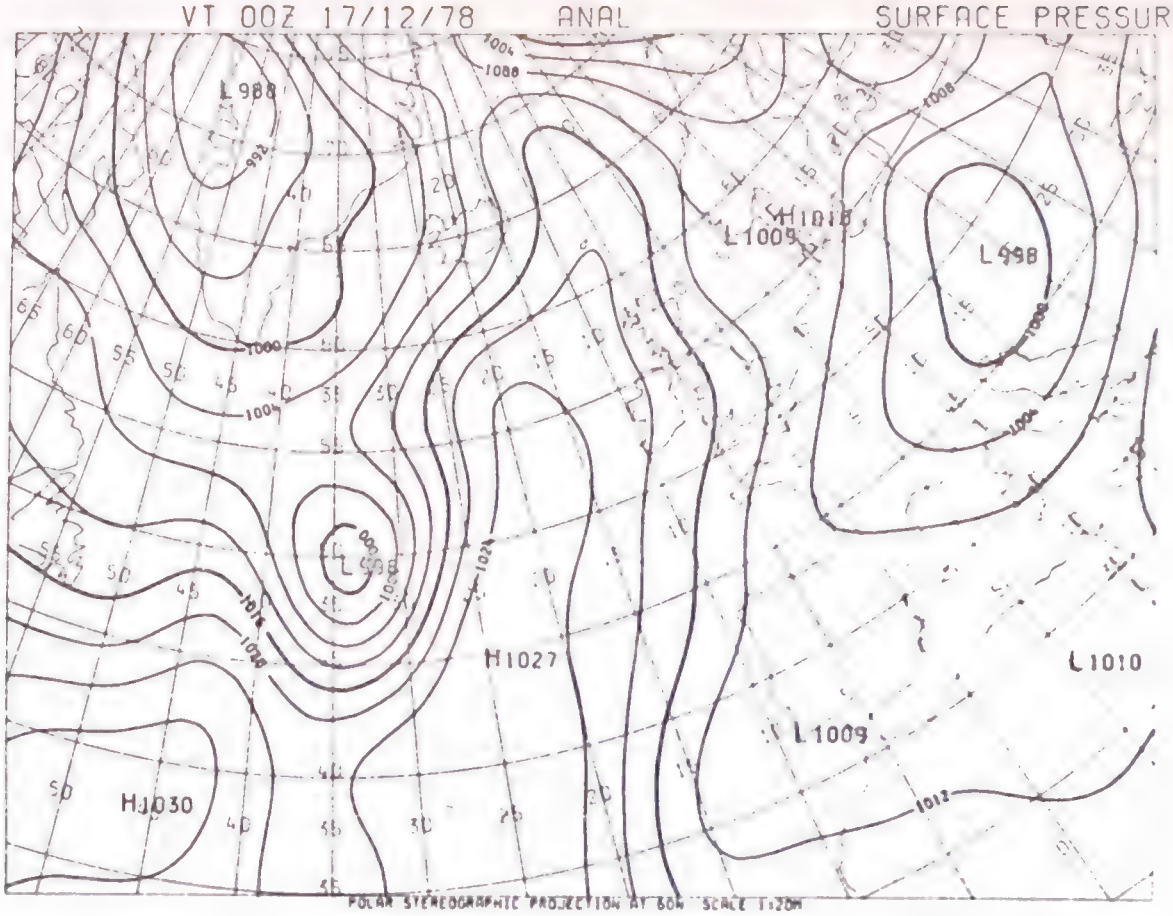
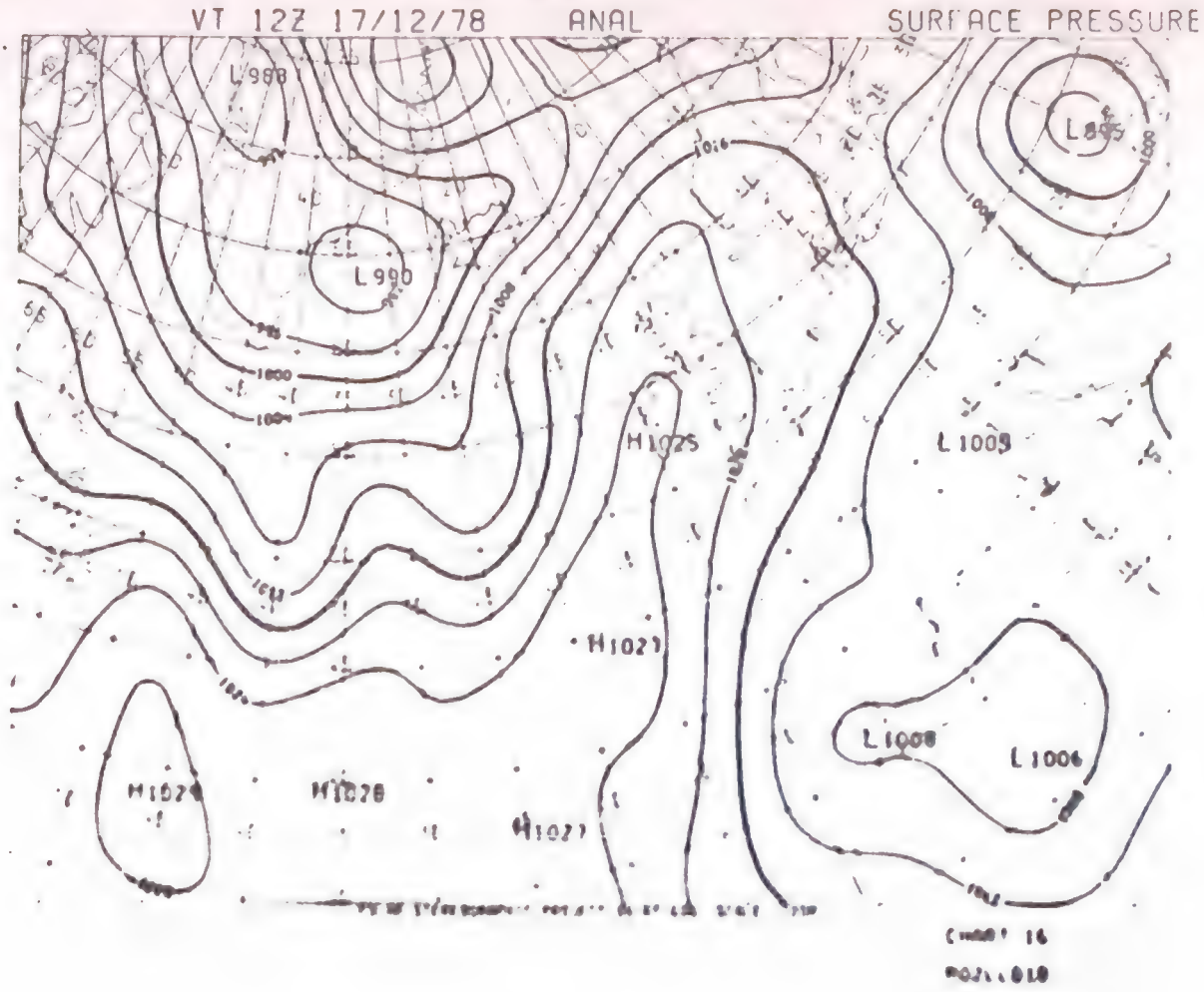


CHART 16

CFO

WITH WEATHER SHIPS



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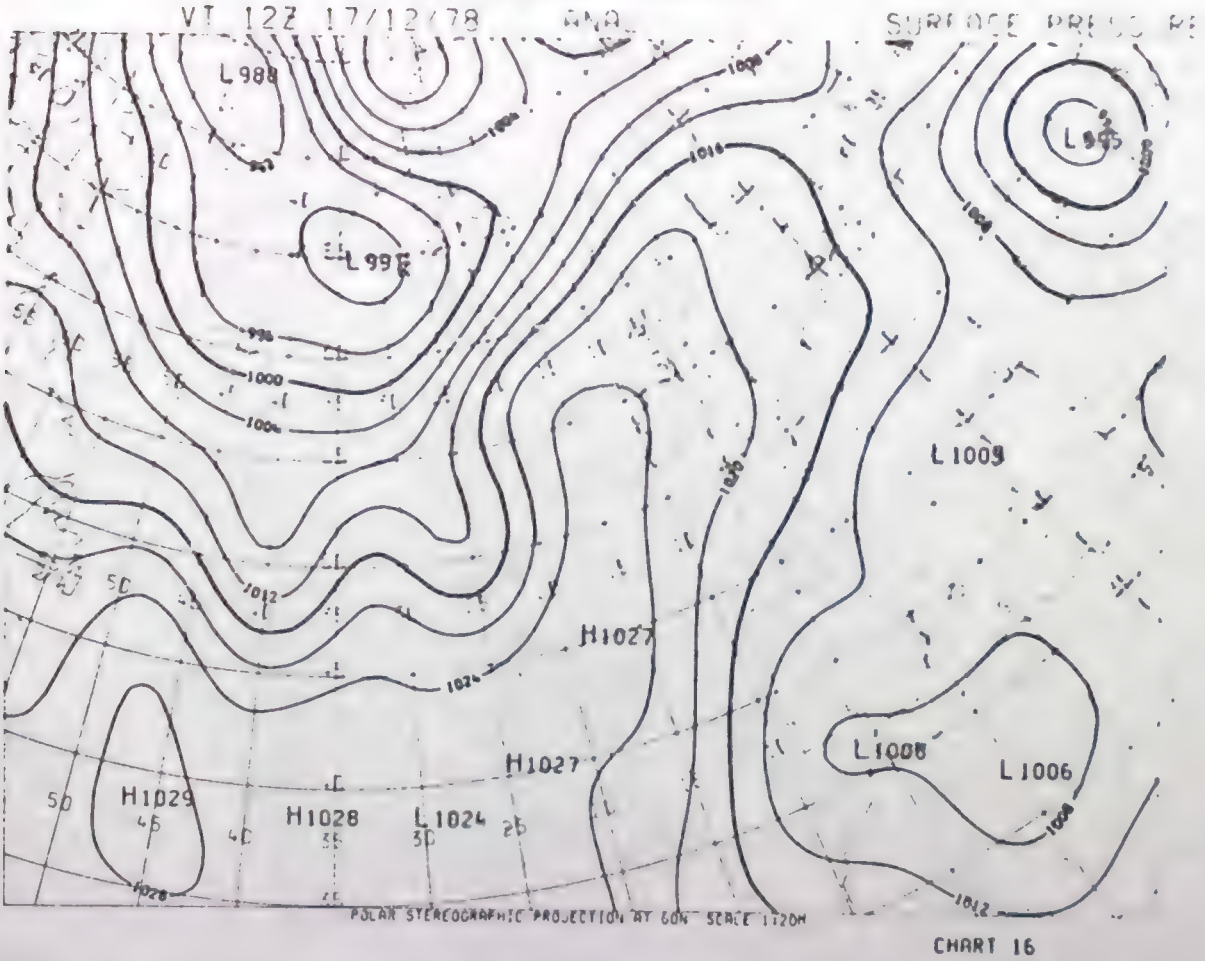

OPERATIONAL

VT 12Z 17/12/78 ANAL SURFACE PRESSURE

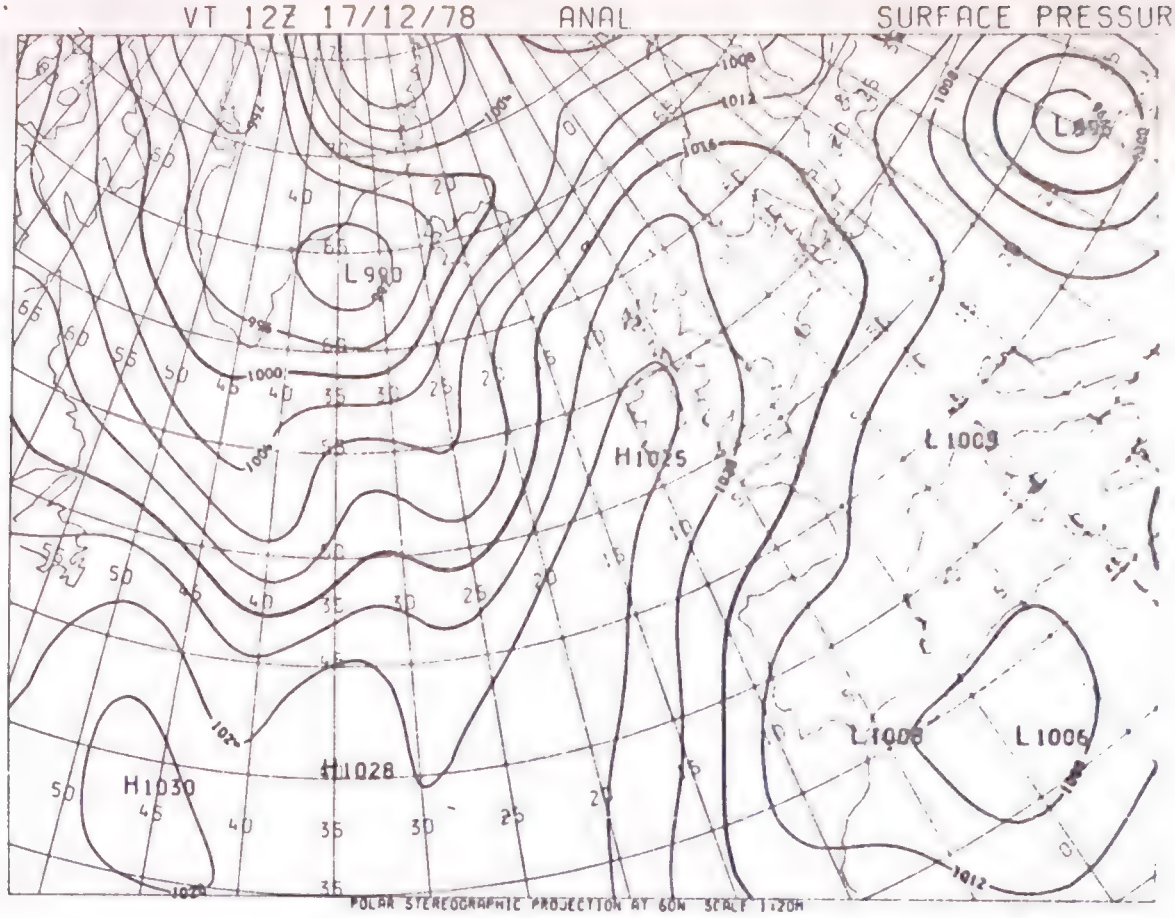

CHART 16

CFO

WITH WEATHER SHIPS

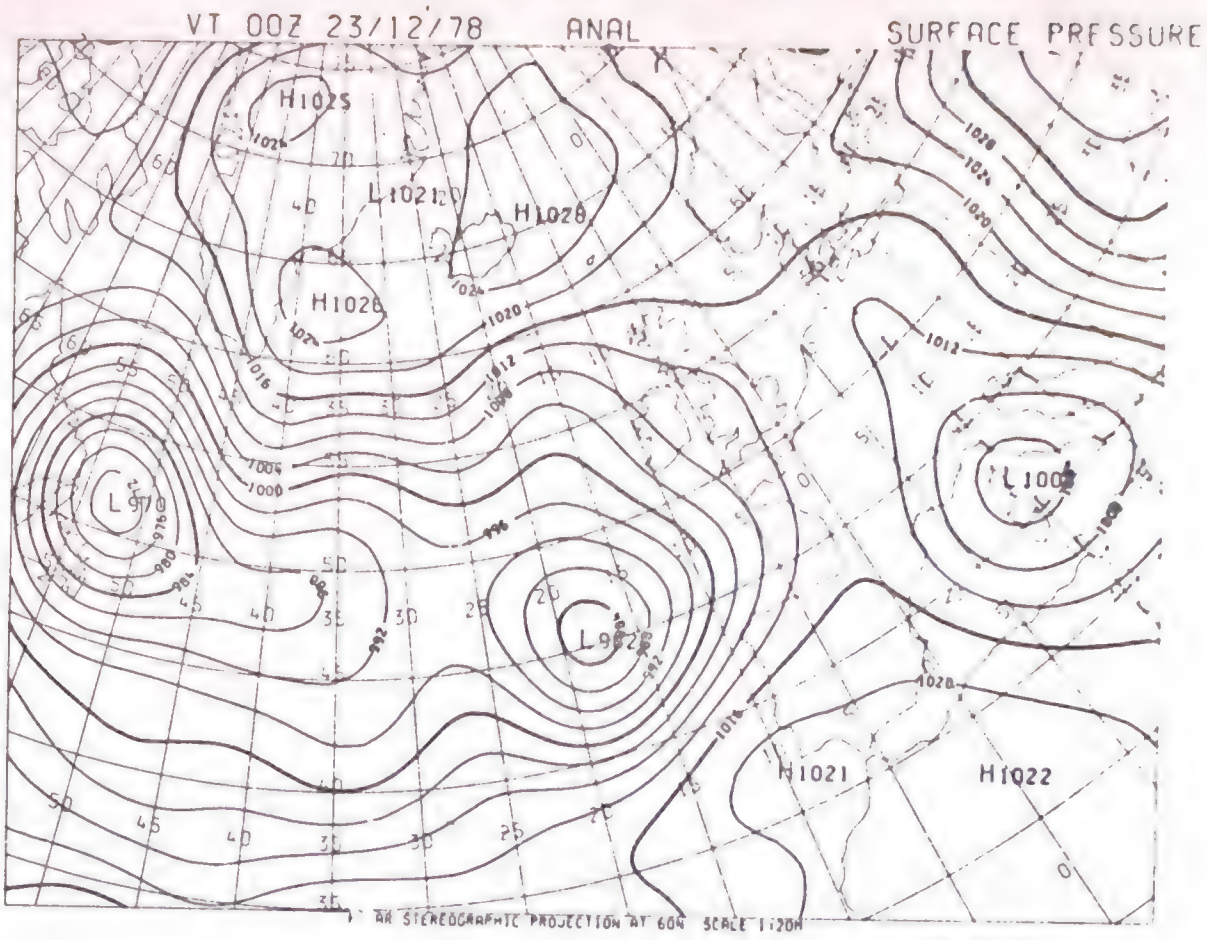

CHART 16

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WITHOUT WEATHER SHIPS

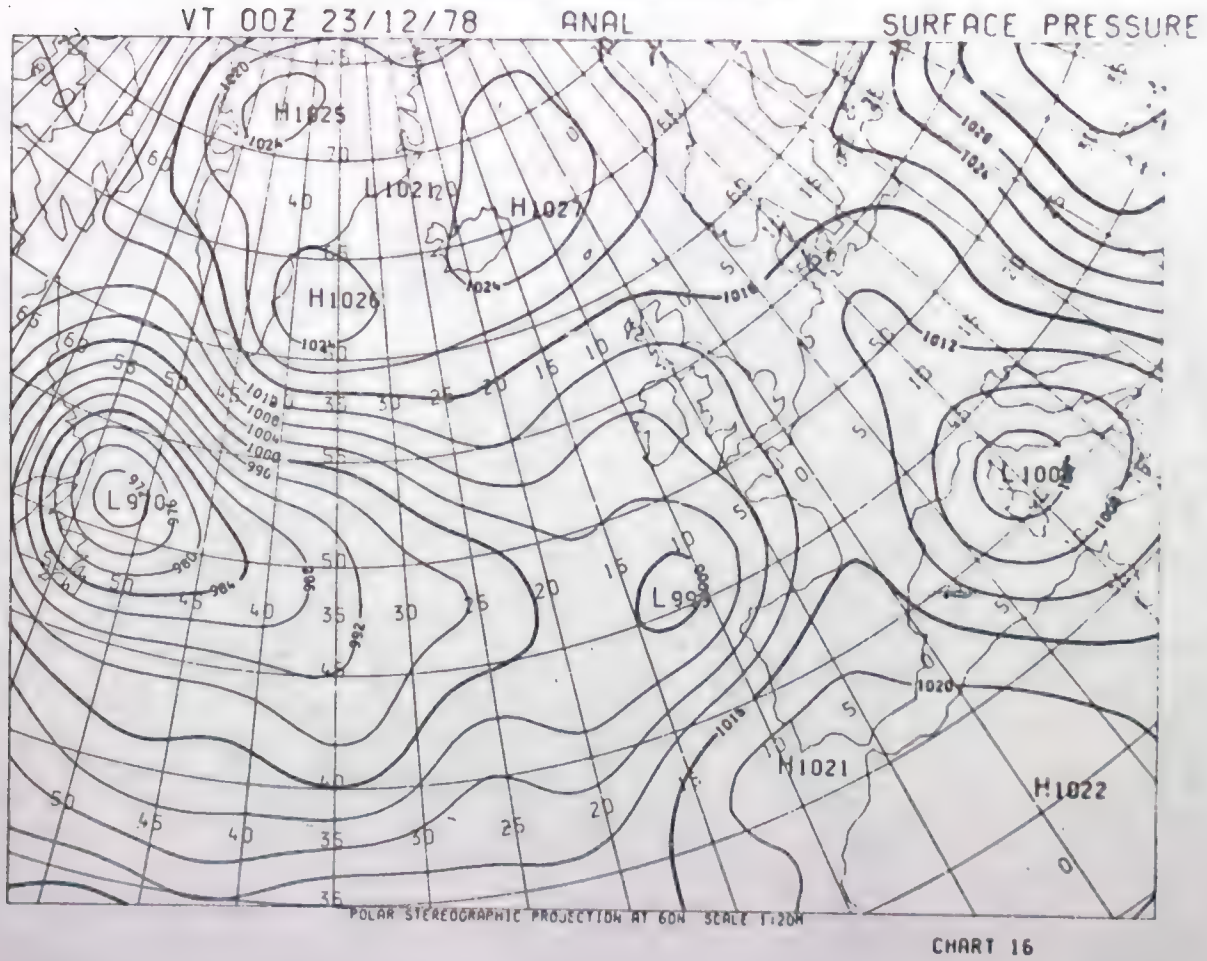

CHART 16

MO2LLD1C

OPERATIONAL

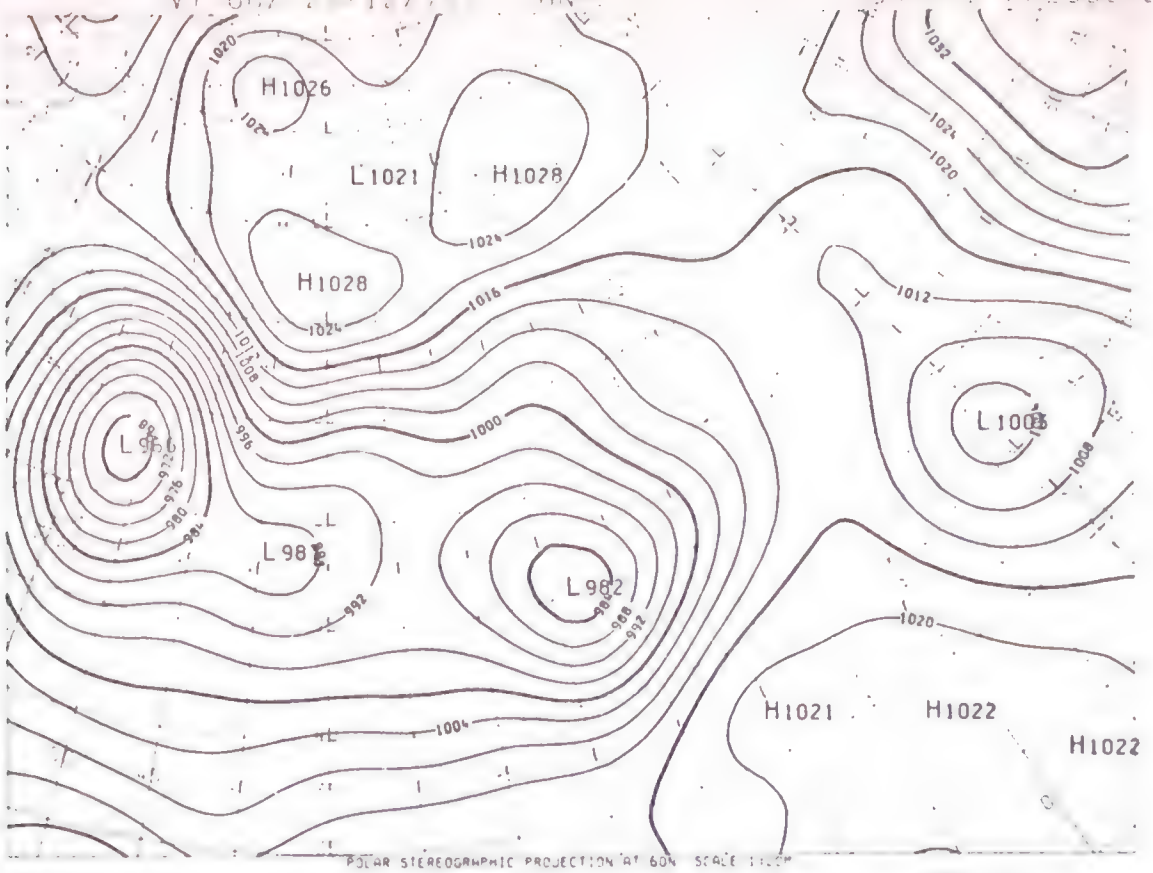

CHART 16

CFO

WITH WEATHER SHIPS

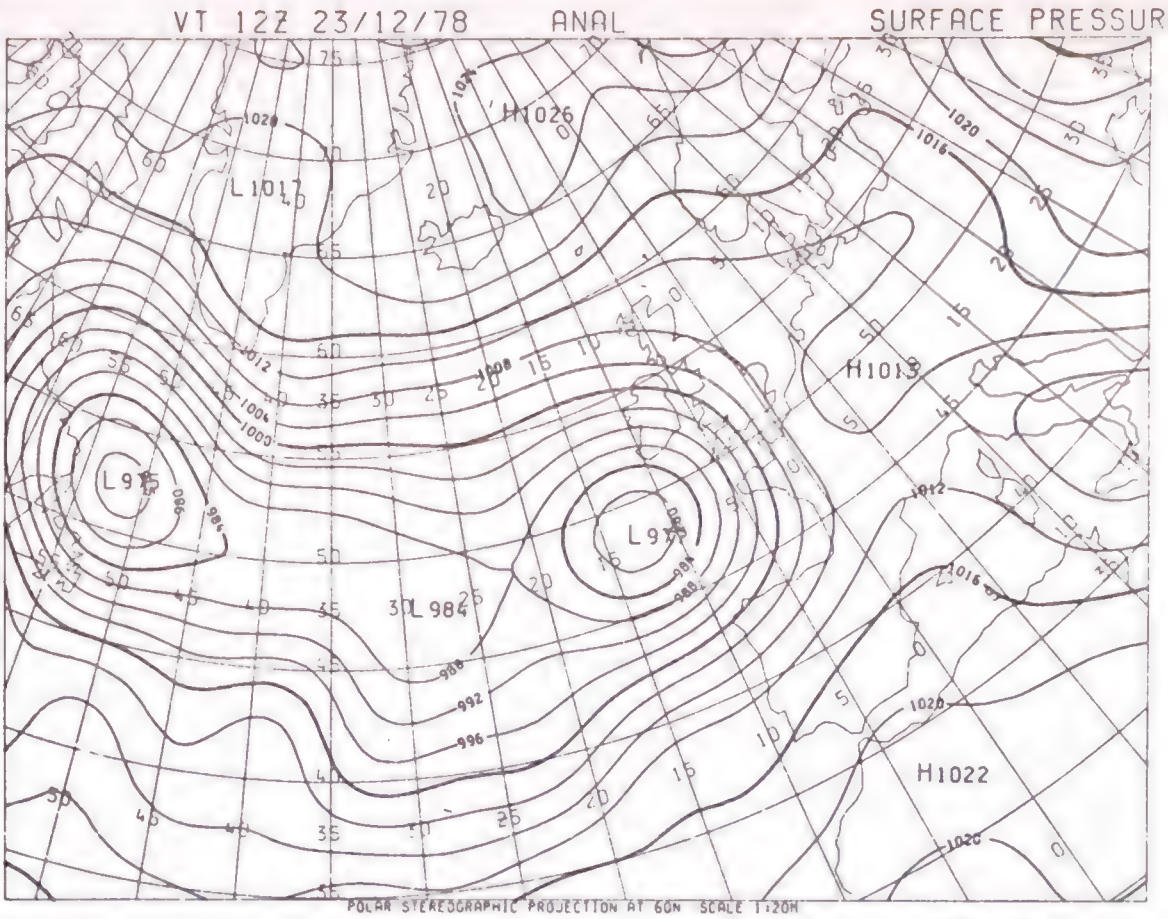

CHART 16

M02LLD1B

WITHOUT WEATHER SHIPS

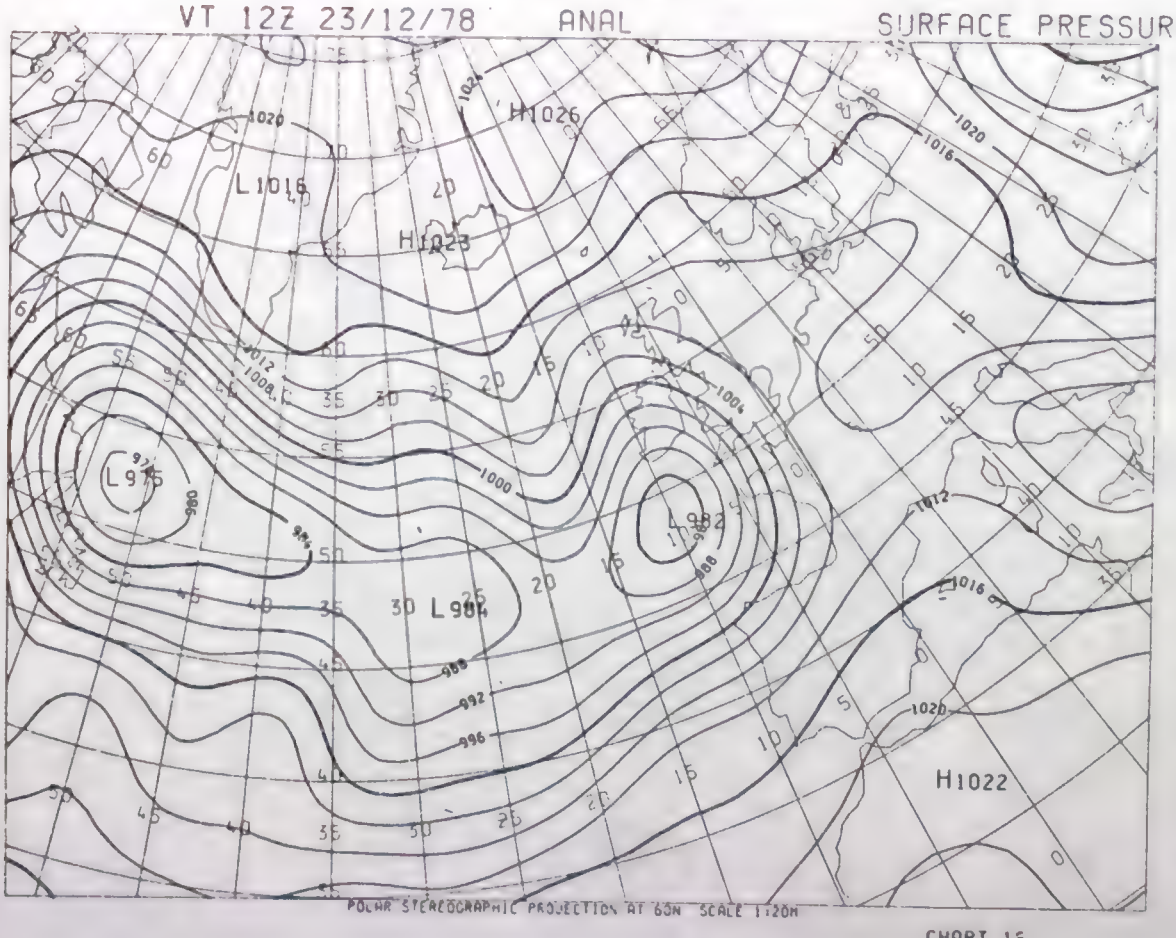

CHART 16

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OPERATIONAL

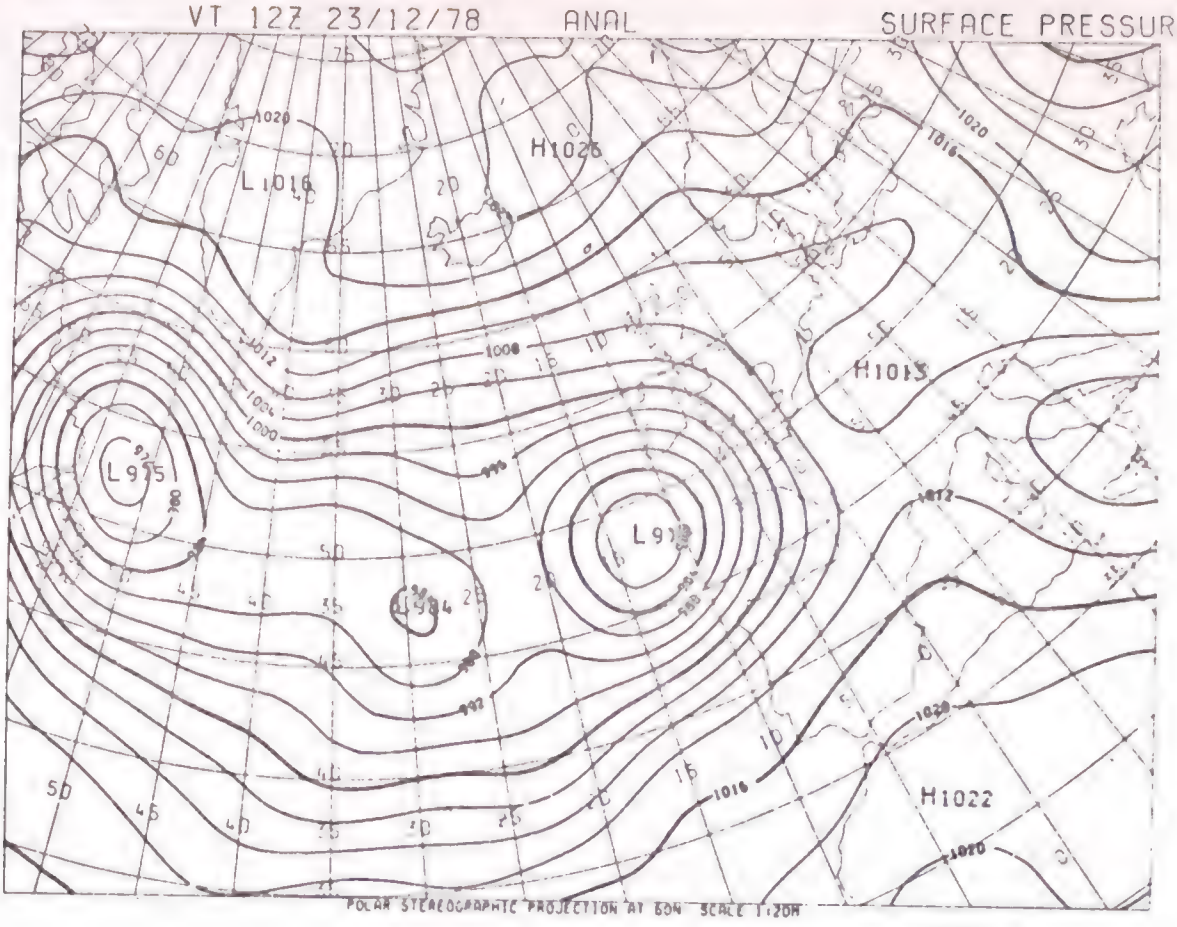
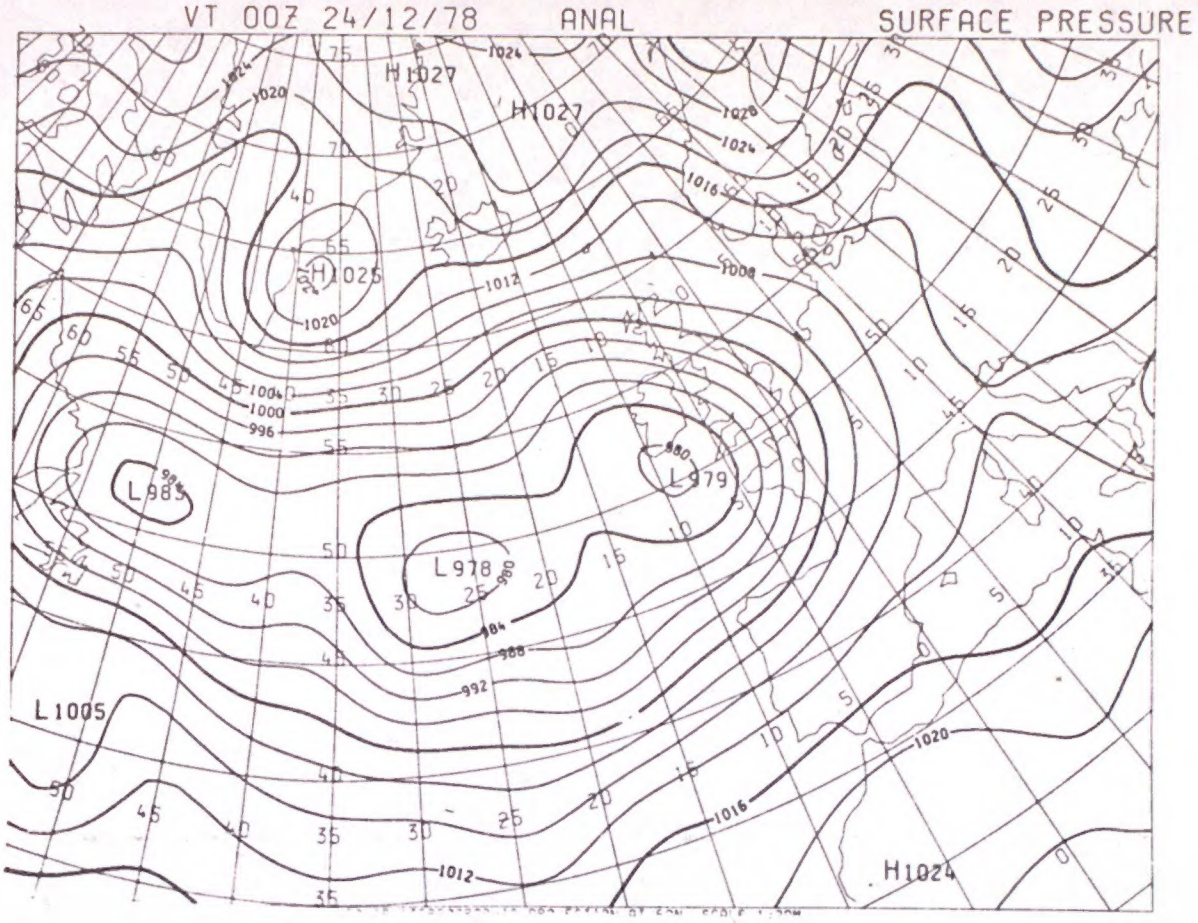


CHART 16

CFO

WITH WEATHER SHIPS



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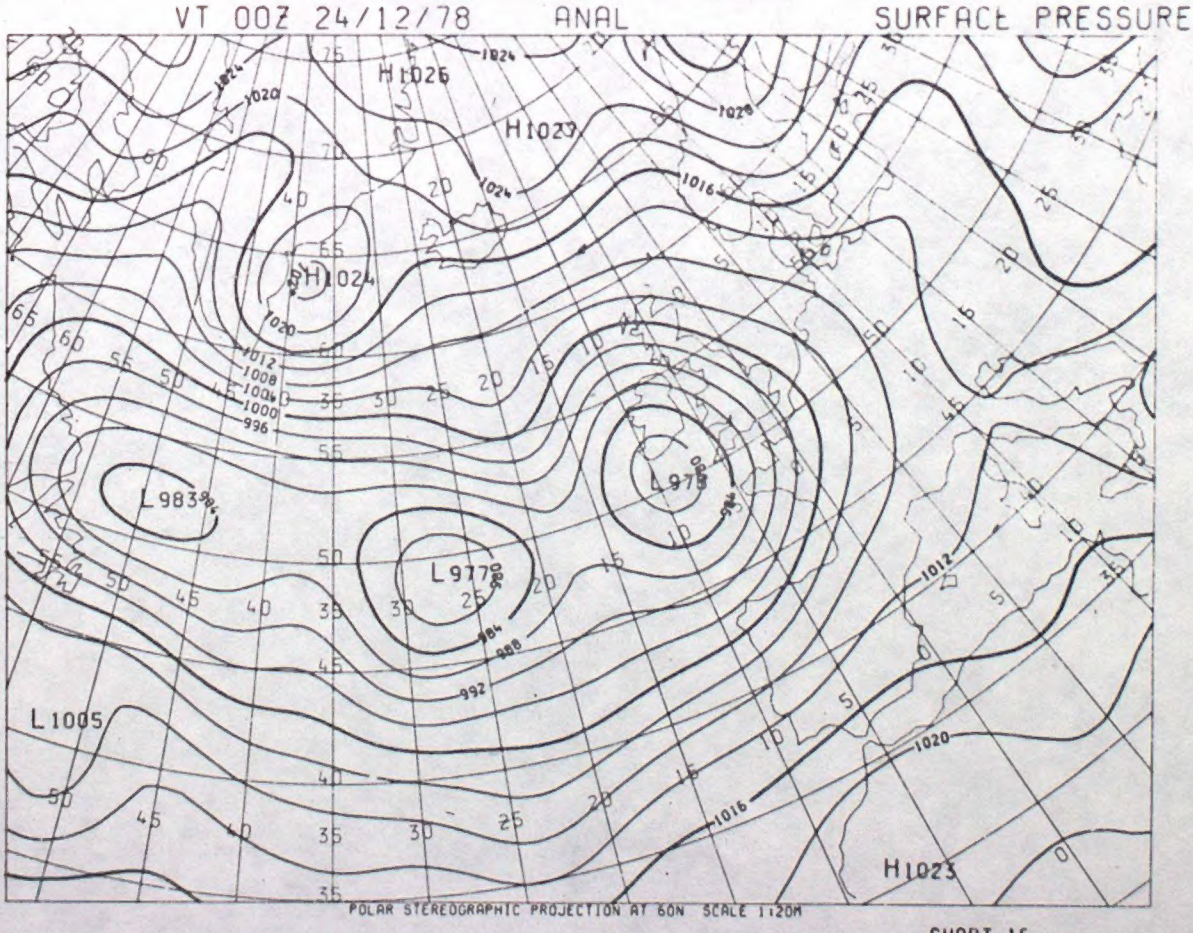
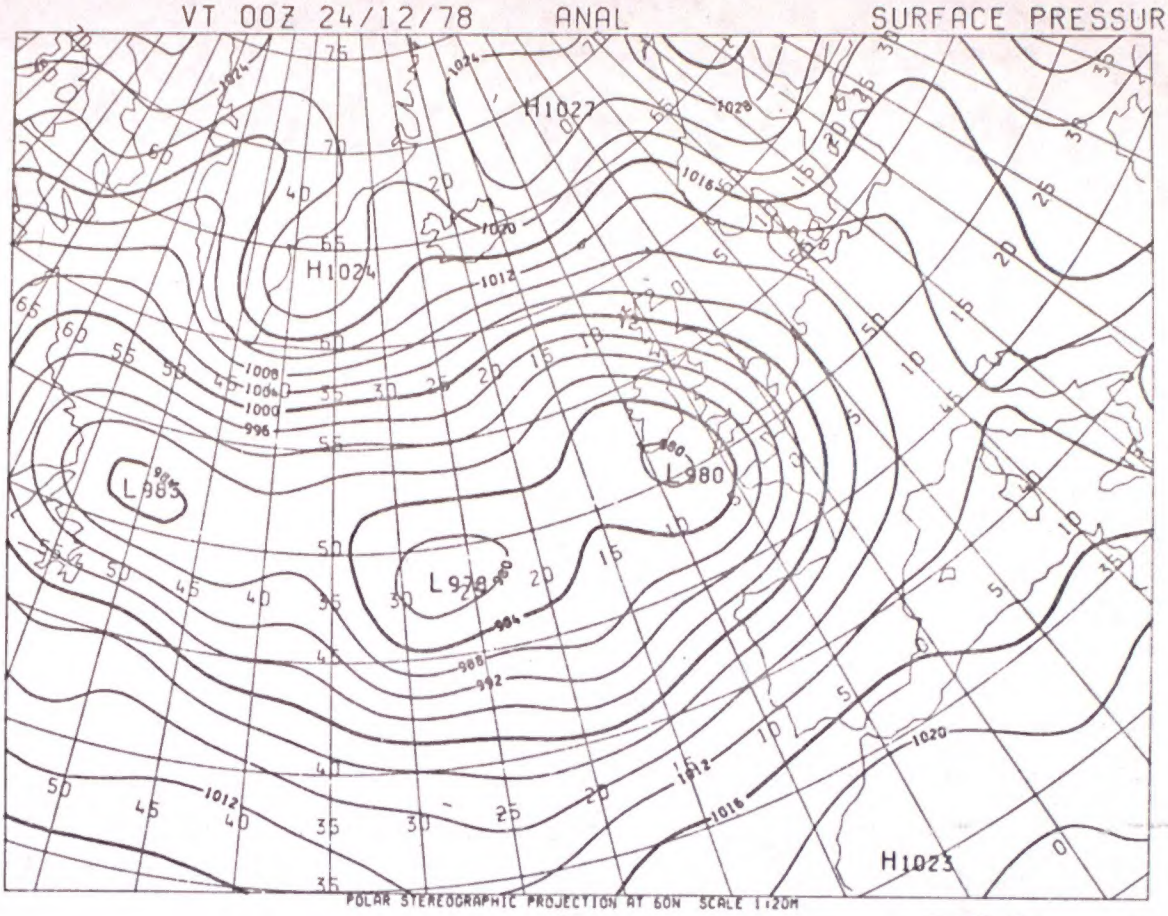


CHART 16

M02LLD1C

OPERATIONAL

VT 00Z 24/12/78 ANAL SURFACE PRESSURE



POLAR STEREOGRAPHIC PROJECTION AT 60N SCALE 1:20M

CHART 16

CFO

WITH WEATHER SHIPS

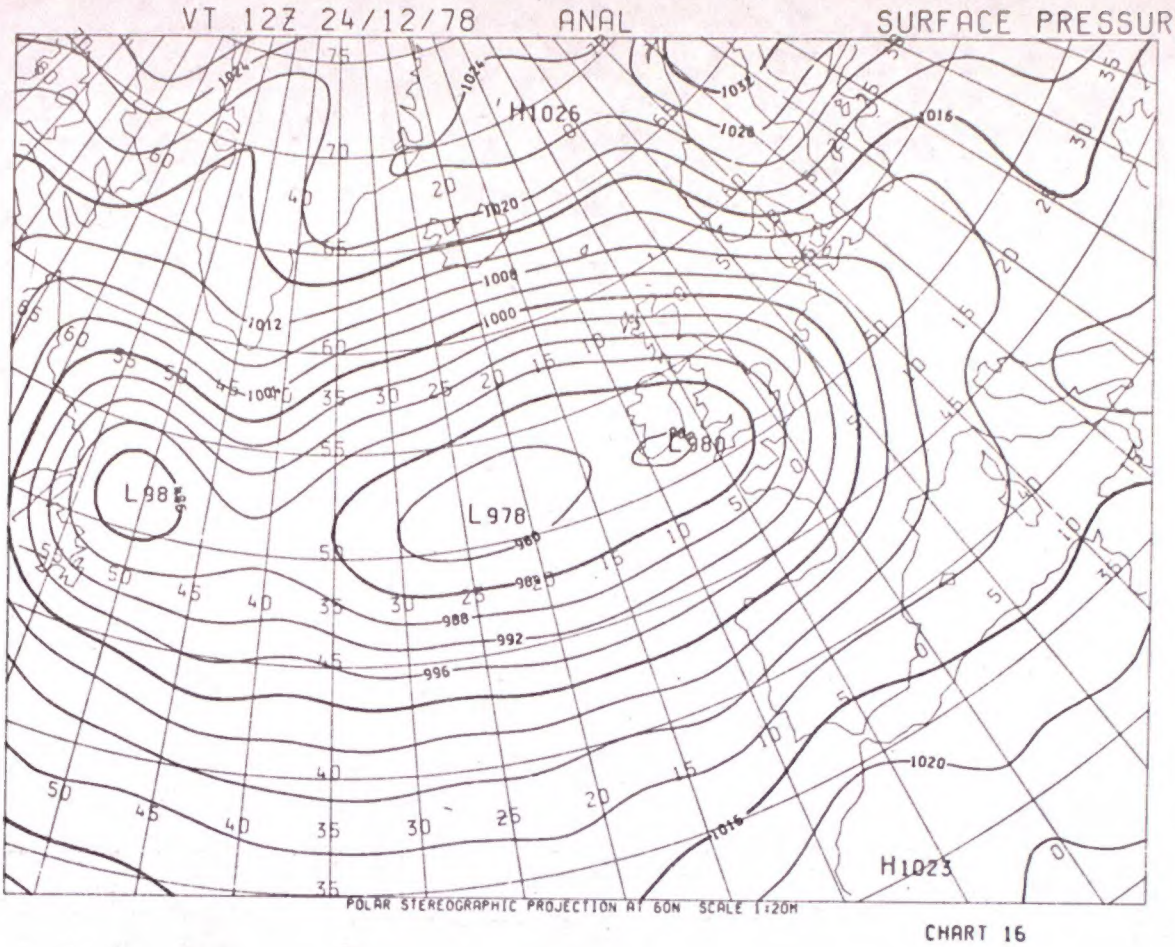


CHART 16
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WITHOUT WEATHER SHIPS

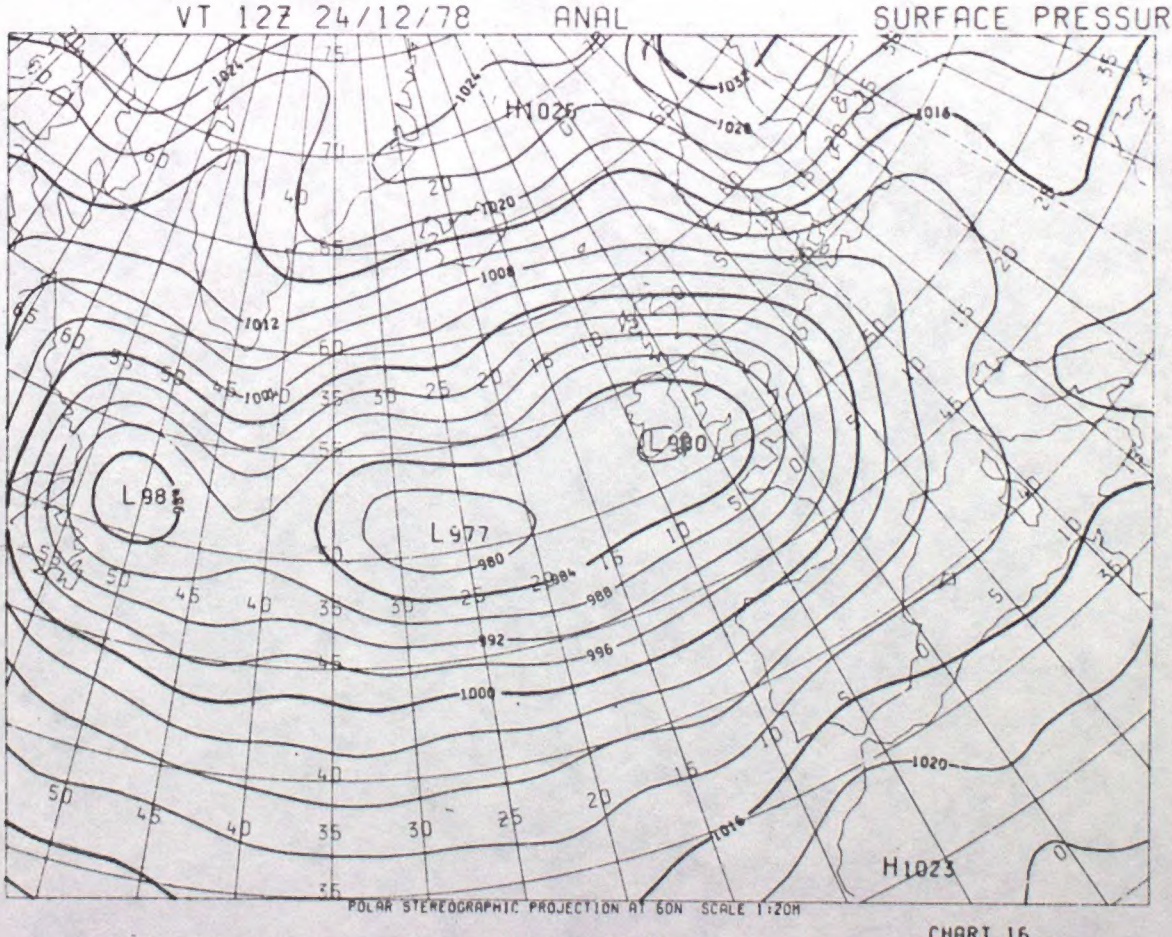
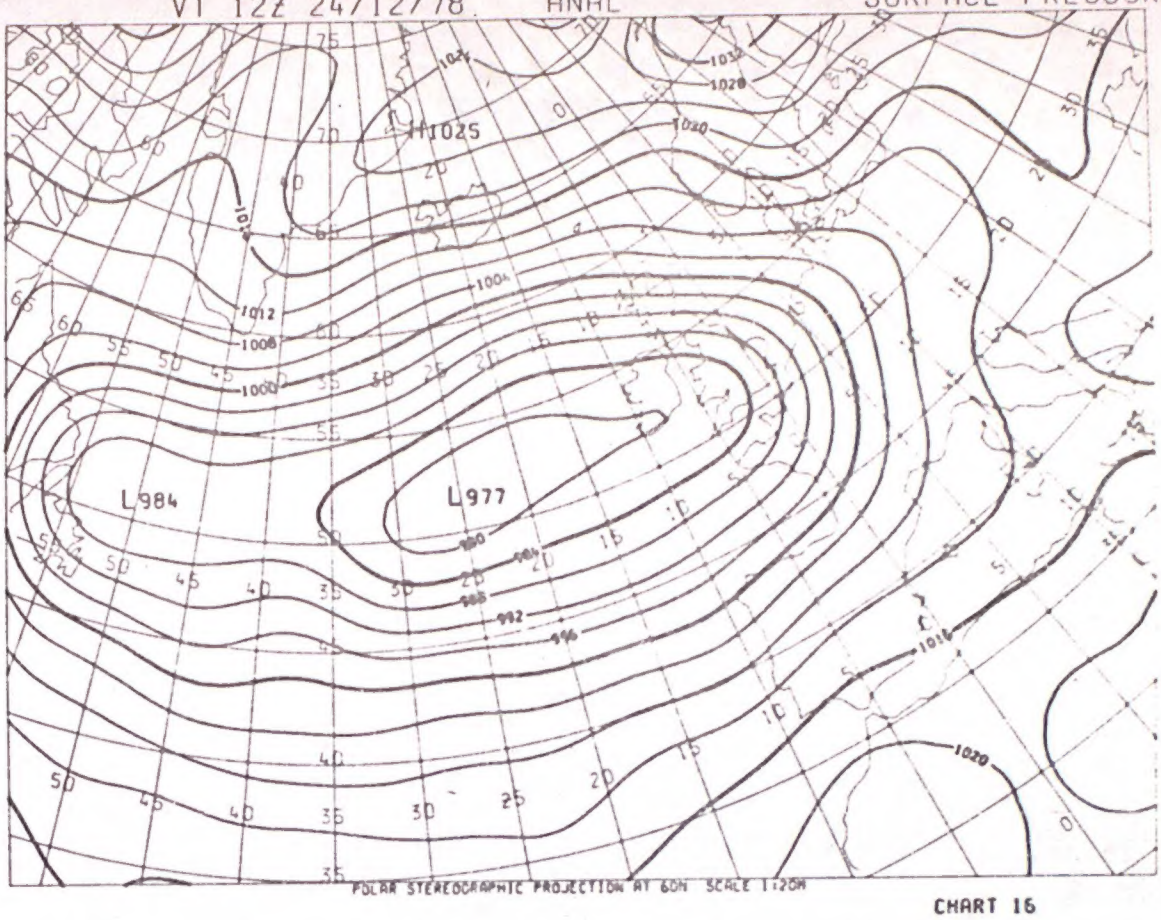


CHART 16
MO2LLD1C

OPERATIONAL

VT 12Z 24/12/78 ANAL SURFACE PRESSURE



POLAR STEREOGRAPHIC PROJECTION AT 60N SCALE 1:20M

CHART 16

CFO